Minerals Yearbook

1987

Volume II

AREA REPORTS: DOMESTIC

Prepared by staff of the

BUREAU OF MINES

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UNITED STATES DEPARTMENT OF THE INTERIOR • Manuel Lujan, Jr., Secretary

BUREAU OF MINES • T S Ary, Director

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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Foreword

This edition of the Minerals Yearbook discusses the performance of the worldwide minerals industry during 1987 and provides background information to assist in interpreting that performance. Content of the individual Yearbook volumes follows:

Volume I, Metals and Minerals, contains chapters on virtually all metallic and industrial mineral commodities important to the U.S. economy. In addition, it includes a statistical summary chapter, a chapter on mining and quarrying trends, and a chapter discussing the statistical surveying methods used by the Bureau of Mines.

Volume II, Area Reports: Domestic, contains chapters on the minerals industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, and the Commonwealth of Puerto Rico. This volume also has a statistical summary.

Volume III, Area Reports: International, contains the latest available mineral data on more than 150 foreign countries and discusses the importance of minerals to the economies of these nations. A separate chapter reviews the international minerals industry in general and its relationship to the world economy.

The Bureau of Mines continually strives to improve the value of its publications to users. Therefore, constructive comments and suggestions by readers of the Yearbook will be welcomed.

T S Ary, *Director*

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Acknowledgments

The chapters of this volume were written by the State Mineral Officers of the Bureau of Mines, located throughout the country. Preparation of the chapters was coordinated by the Office of State Activities, Division of Mineral Commodities.

The Statistical Summary chapter and the tabular material covering total State mineral production and mineral production by county, were prepared in the Division of Mineral Commodities.

Compilations contained in this volume were based largely on statistics and other data provided by the minerals industries. The Bureau gratefully acknowledges the willing contribution of these essential data by both companies and individuals.

In the collection of statistical and other mineral-industry information, the Bureau of Mines was also assisted by various State agencies through cooperative agreements. Many of the chapters in Volume II were reviewed by staff members of these agencies; in some instances the staff members collaborated in preparing the chapters and are shown as coauthors. Our sincere appreciation for this assistance is extended to the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources.
Arizona: Arizona Department of Mines and Mineral Resources.
Arkansas: Arkansas Geological Commission.
California: California Department of Conservation, Division of Mines and Geology.
Colorado: Colorado Geological Survey.
Connecticut: State Geological and Natural History Survey of Connecticut, Department of Environmental Protection.
Delaware: Delaware Geological Survey.
Florida: Florida Bureau of Geology.
Georgia: Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources.
Hawaii: Department of Land and Natural Resources.
Idaho: Idaho Geological Survey.
Illinois: State Geological Survey Division, Illinois Department of Energy and Natural Resources.
Indiana: Geological Survey, Indiana Department of Natural Resources.
Iowa: Geological Survey Bureau, Division of Energy and Geological Resources, Iowa Department of Natural Resources.
Kansas: Kansas Geological Survey.
Kentucky: Kentucky Geological Survey.
Louisiana: Louisiana Geological Survey.
Maine: Maine Geological Survey.
Maryland: Maryland Geological Survey.
Massachusetts: Commonwealth of Massachusetts, Executive Office of Environmental Affairs.
Michigan: Geological Survey Division, Michigan Department of Natural Resources.
Minnesota: Mineral Resources Research Center, University of Minnesota.
Mississippi: Bureau of Geology, Mississippi Department of Natural Resources.

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Missouri: Missouri Department of Natural Resources, Division of Geology and Land Survey.
Montana: Montana Bureau of Mines and Geology.
Nebraska: Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey).
Nevada: Nevada Bureau of Mines and Geology.
New Hampshire: New Hampshire Department of Environmental Services.
New Jersey: Geological Survey, Division of Water Resources, New Jersey Department of Environmental Protection.
New Mexico: New Mexico Bureau of Mines and Mineral Resources.
New York: New York State Education Department, New York Geological Survey.
North Carolina: Division of Land Resources, North Carolina Department of Natural Resources and Community Development.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey.
Oregon: Oregon Department of Geology and Mineral Industries.
Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources.
Puerto Rico: Department of Natural Resources, Commonwealth of Puerto Rico.
Rhode Island: Department of Environmental Management.
South Carolina: South Carolina Geological Survey, State Division of Research and Statistical Services.
South Dakota: South Dakota Geological Survey.
Tennessee: Tennessee Division of Geology.
Texas: Bureau of Economic Geology, The University of Texas at Austin.
Utah: Utah Geological and Mineral Survey.
Vermont: Office of the State Geologist, Agency of Environmental Conservation.
Virginia: Virginia Division of Mineral Resources.
Washington: Washington Division of Geology and Earth Resources.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological and Natural History Survey.
Wyoming: Geological Survey of Wyoming.

Donald S. Colby, *Chief, Office of State Activities*

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Statistical Summary

By Stephen D. Smith[1]

This chapter summarizes data on crude nonfuel mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Also included are tables that show the principal nonfuel mineral commodities exported from and imported into the United States and that compare world and U.S. mineral production. The detailed data from which these tables were derived are contained in the individual commodity chapters of Volume I and in the State chapters of Volume II of this edition of the Minerals Yearbook.

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this chapter is what is normally termed "mine output." It usually refers to minerals or ores in the form in which they are first extracted from the ground, but customarily includes the output from auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. For copper, gold, lead, silver, tin, and zinc, the quantities are recorded on a mine basis (as the recoverable content of ore sold or treated). However, the values assigned to these quantities are based on the average selling price of refined metal, not the mine value. Mercury is measured as recovered metal and valued at the average New York price for the metal.

The weight or volume units shown are those customarily used in the particular industries producing the commodities. Values shown are in current dollars, with no adjustments made to compensate for changes in the purchasing power of the dollar.

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[1]Mineral data assistant, Section of Ferrous Metals Data. The author was assisted in the preparation of this chapter by Barbara M. Carrico, Chief, Section of Nonferrous Metals Data; Sarah P. Guerrino, Chief, Section of Ferrous Metals Data; Barbara E. Gunn, Chief, Section of Industrial Minerals Data; William L. Zajac, Chief, Branch of Geographic Data.

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Table 1.—Nonfuel mineral production[1] in the United States

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS						
Bauxite thousand metric tons, dried equivalent	674	$12,855	510	r$10,361	576	$10,871
Copper (recoverable content of ores, etc.) metric tons	1,105,758	1,632,483	1,147,277	1,670,660	1,255,914	2,284,156
Gold (recoverable content of ores, etc.) troy ounces	2,427,232	771,032	r3,739,015	r1,376,855	4,966,382	2,224,691
Iron oxide pigments, crude short tons	46,585	2,826	40,987	2,908	42,773	3,598
Lead (recoverable content of ores, etc.) metric tons	413,955	174,008	339,793	165,150	311,298	246,654
Magnesium metal[2] short tons	--	--	138,493	423,788	137,123	381,914
Manganiferous ore (5% to 35% Mn) short tons, gross weight	19,882	W	14,320	W	19,087	W
Mercury 76-pound flasks	16,530	W	W	W	W	W
Molybdenum (content of ore and concentrate) thousand pounds	111,936	347,812	95,006	240,484	69,868	179,286
Nickel (content of ore and concentrate) short tons	6,127	W	1,175	W	--	--
Silver (recoverable content of ores, etc.) thousand troy ounces	39,433	242,205	r34,524	r188,846	39,790	278,930
Tungsten (content of ore and concentrate) metric tons	983	9,143	817	5,774	W	W
Zinc (recoverable content of ores, etc.) metric tons	226,545	201,607	202,983	170,050	216,981	200,529
Combined value of antimony (1985-86), beryllium concentrates, iron ore (usable), magnesium chloride for magnesium metal (1985),[3] platinum-group metals (1987), rare-earth metal concentrates, tin, titanium concentrates (ilmenite and rutile), vanadium, zircon concentrates, and values indicated by symbol W	XX	2,234,916	XX	r1,562,566	XX	1,636,688
Total[4]	XX	5,629,000	XX	r5,817,000	XX	7,447,000
INDUSTRIAL MINERALS (EXCEPT FUELS)						
Abrasives[5] short tons	1,157	515	W	W	12,773	957
Asbestos metric tons	57,457	20,485	51,437	17,367	50,600	17,198
Barite thousand short tons	739	21,501	297	12,326	448	15,810
Boron minerals do.	1,269	404,775	1,251	426,086	1,385	475,092
Bromine[6] thousand pounds	320,000	80,000	310,000	93,000	335,000	107,000
Cement:						
Masonry thousand short tons	3,187	213,096	3,525	231,551	3,680	259,926
Portland do.	74,250	3,817,335	75,181	3,759,942	74,868	3,646,561
Clays do.	44,974	1,011,377	44,620	1,095,179	47,657	1,202,284
Diatomite do.	635	127,030	628	128,362	658	134,239
Emery short tons	W	W	2,878	W	1,945	W
Feldspar do.	700,000	22,800	735,000	26,100	720,000	26,100
Fluorspar do.	66,000	W	e78,000	W	68,839	11,725
Garnet (abrasive) do.	36,727	2,973	32,296	2,603	42,277	4,350
Gem stones	NA	e7,425	NA	9,247	NA	21,389
Gypsum thousand short tons	r14,414	r111,785	r15,403	r99,570	15,612	106,977
Helium:						
Crude million cubic feet	W	W	432	9,504	730	16,068
Grade-A do.	1,865	69,938	1,941	72,788	2,230	82,540
Lime thousand short tons	15,690	809,000	14,474	757,867	15,733	786,125
Mica (scrap) do.	138	6,330	148	7,108	161	8,201
Peat do.	882	21,892	r1,038	r23,988	958	26,170
Perlite do.	507	17,160	507	15,646	533	16,494
Phosphate rock thousand metric tons	50,835	r1,235,800	r40,320	r897,131	40,954	793,280
Potassium salts (K_2O equivalent) do.	1,266	178,400	1,147	152,000	1,485	195,700
Pumice thousand short tons	508	4,553	554	5,756	392	4,498
Salt do.	40,067	739,609	36,663	665,400	36,493	684,170
Sand and gravel:						
Construction do.	e800,100	e2,438,000	883,000	2,747,200	896,200	3,002,500
Industrial do.	29,430	374,070	27,420	359,300	28,010	364,100
Sodium carbonate (natural) do.	W	W	W	W	8,891	593,685
Sodium sulfate (natural) do.	389	35,860	396	34,102	382	33,086
Stone:[6]						
Crushed do.	1,000,800	4,053,000	e1,023,200	e4,255,000	1,200,100	5,248,600
Dimension do.	1,104	172,435	e1,163	e173,269	1,184	190,153
Sulfur, Frasch process thousand metric tons	4,678	573,570	4,180	508,512	3,610	386,834

See footnotes at end of table.

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Table 1.—Nonfuel mineral production[1] in the United States —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS (EXCEPT FUELS) —Continued						
Talc and pyrophyllite thousand short tons	1,269	$29,188	1,302	$31,227	1,349	$28,785
Tripoli short tons	W	W	117,174	918	114,926	975
Vermiculite thousand short tons	314	32,400	317	34,400	303	33,105
Combined value of aplite, asphalt (native, 1985-86), calcium chloride (natural), iodine, kyanite, lithium minerals, magnesite, magnesium compounds,[7] marl (greensand), olivine, pyrites, staurolite, wollastonite, and values indicated by symbol W	XX	1,046,003	XX	r994,446	XX	374,118
Total[4]	XX	r17,678,000	XX	r17,647,000	XX	18,899,000
Grand total[4]	XX	r23,307,000	XX	r23,464,000	XX	26,346,000

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Magnesium metal (refinery production) not reported in 1985.
[3]Magnesium chloride for magnesium metal reporting discontinued in 1986.
[4]Data may not add to totals shown because of independent rounding.
[5]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.
[6]Excludes abrasive stone and bituminous limestone and sandstone; all included elsewhere in table.
[7]Excludes values that must be concealed to avoid disclosing company proprietary data.

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Table 2.—Nonfuel minerals produced in the United States and principal producing States in 1987

Mineral	Principal producing States, in order of quantity	Other producing States
Abrasives[1]	OH, AR, IN, WI.	
Antimony (content of ore, etc.)	[2]	
Aplite	VA.	
Asbestos	CA and VT.	
Asphalt (native)	[3]	
Barite	NV, GA, MO, CA	MT, TN.
Bauxite	AR, AL, GA.	
Beryllium concentrate	UT and SD.	
Boron minerals	CA.	
Bromine	AR and MI.	
Calcium chloride (natural)	MI, CA, WA.	
Cement:		
Masonry	IN, PA, FL, AL	All other States except AK, CT, DE, MA, MN, NC, ND, NH, NJ, NV, RI, VT.
Portland	CA, TX, PA, MO	All other States expect CT, DE, MA, MN, NC, ND, NH, NJ, RI, VT.
Clays	GA, TX, NC, OH	All other States except AK, DE, HI, RI, VT, WI.
Copper (content of ores, etc.)	AZ, NM, MI, MT	CO, ID, IL, MO, TN, WA.
Diatomite	CA, NV, WA, OR.	
Emery	NY.	
Feldspar	NC, CT, CA, GA	OK, SD.
Fluorspar	IL and NV.	
Garnet (abrasive)	ID, NY, ME.	
Gold (content of ores, etc.)	NV, CA, SD, UT	AK, AZ, CO, ID, MI, MT, NM, OR, SC, WA.
Gypsum	MI, IA, TX, OK	AR, AZ, CA, CO, IN, KS, LA, MT, NM, NV, NY, OH, SD, UT, VA, WA, WY.
Helium	KS, WY, TX, NM.	
Iodine	OK.	
Iron ore (usable)	MN, MI, MO, UT	CA, MT, NM, TX.
Iron oxide pigments (crude)	MI, GA, MO, VA.	
Kyanite	VA.	
Lead (content of ores, etc.)	MO, CO, ID, MT	IL, NM, NY, TN.
Lime	OH, MO, PA, KY	All other States except AK, CT, DE, FL, GA, KS, ME, MS, NH, NJ, NM, NC, NY, RI, SC, VT.
Lithium minerals	NC and NV.	
Magnesite	NV.	
Magnesium compounds	MI, CA, UT, DE	TX.
Magnesium metal	TX, WA, UT.	
Manganiferous ore	SC.	
Marl (greensand)	DE and NJ.	
Mercury	NV, UT, CA.	
Mica (scrap)	NC, SD, NM, SC	CT, GA, PA.
Molybdenum	CO, ID, AZ, MT	CA, NM, UT.
Nickel	[2]	
Olivine	NC and WA.	
Peat	FL, MI, IL, CA	CO, GA, IA, IN, MA, MD, MN, MT, NC, NJ, NY, ND, OH, PA, SC, WA, WI, WV.
Perlite	NM, AZ, CA, ID	CO, NV.
Phosphate rock	FL, NC, ID, TN	MT, UT.
Platinum-group metals	MT.	
Potassium salts	NM, UT, CA.	
Pumice	OR, NM, CA, ID	AZ, HI, KS.
Pyrites (ore and concentrate)	TN, AZ, CO, NM.	
Rare-earth metal concentrate	CA and FL.	
Salt	LA, TX, NY, OH	AL, AZ, CA, KS, MI, ND, NM, NV, OK, UT, WV.
Sand and gravel:		
Construction	CA, TX, MI, AZ	All other States.
Industrial	IL, MI, CA, NJ, AL	All other States except AK, DE, HI, IA, ME, NH, NM, OR, SD, VT, WY.
Silver (content of ores, etc.)	NV, ID, MT, UT	AK, AZ, CA, CO, IL, MI, MO, NM, NY, OR, SC, SD, TN, WA.
Sodium carbonate (natural)	WY and CA.	
Sodium sulfate (natural)	CA and TX.	
Staurolite	FL.	
Stone:		
Crushed	PA, TX, FL, GA	All other States except DE.
Dimension	IN, GA, VT, MA	All other States except AK, DE, FL, HI, KY, LA, MS, ND, NE, NJ, NV, OR, RI, WV, WY.
Sulfur (Frasch)	TX and LA.	
Talc and pyrophyllite	MT, VT, TX, NY	AR, CA, GA, NC, OR, VA.
Tin	AK.	
Titanium concentrates	FL.	
Tripoli	IL, OK, AR, PA.	
Tungsten (content of ore, etc.)	CA.	
Vanadium (content of ore, etc.)	ID, CO, UT.	
Vermiculite (crude)	SC, MT, VA.	
Wollastonite	NY and CA.	
Zinc (content of ores, etc.)	TN, NY, MO, CO	ID, IL, KY, MT.
Zircon concentrate	FL and NJ.	

[1]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.
[2]No production reported.
[3]Data no longer available.

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Table 3.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1987

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$446,643	20	1.70	Cement (portland), stone (crushed), lime, sand and gravel (construction).
Alaska	125,280	40	.48	Sand and gravel (construction), gold, stone (crushed), cement (portland).
Arizona	1,791,043	2	6.80	Copper, sand and gravel (construction), cement (portland), gold, stone (crushed).
Arkansas	264,162	32	1.00	Bromine, stone (crushed), cement (portland), sand and gravel (construction).
California	2,551,285	1	9.68	Cement (portland), sand and gravel (construction), boron minerals, gold.
Colorado	372,990	23	1.42	Sand and gravel (construction), gold, molybdenum, cement (portland).
Connecticut	122,275	41	.46	Stone (crushed), sand and gravel (construction), feldspar, sand and gravel (industrial).
Delaware[1]	6,401	50	.02	Sand and gravel (contruction), magnesium compounds, marl (greensand), gem stones.
Florida	1,346,237	6	5.11	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction).
Georgia	1,212,370	7	4.60	Clays, stone (crushed), cement (portland), sand and gravel (construction).
Hawaii	73,479	44	.28	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Idaho	269,373	31	1.02	Silver, phosphate rock, gold, molybdenum.
Illinois	517,206	17	1.96	Stone (crushed), sand and gravel (construction), cement (portland), sand and gravel (industrial).
Indiana	363,865	25	1.38	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Iowa	305,077	29	1.16	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude).
Kansas	319,604	28	1.21	Cement (portland), salt, stone (crushed), sand and gravel (construction).
Kentucky	290,335	30	1.10	Stone (crushed), lime, cement (portland), sand and gravel (construction).
Louisiana	424,221	22	1.61	Sulfur (Frasch), salt, sand and gravel (construction), stone (crushed).
Maine	65,457	46	.25	Cement (portland), sand and gravel (construction), stone (crushed), stone (dimension).
Maryland	345,134	26	1.31	Stone (crushed), sand and gravel (construction), cement (portland), cement (masonry).
Massachusetts	176,522	37	.67	Stone (crushed), sand and gravel (construction), stone (dimension), lime.
Michigan	1,365,610	5	5.18	Iron ore (usable), cement (portland), stone (crushed), sand and gravel (construction).
Minnesota	1,142,749	8	4.34	Iron ore (usable), sand and gravel (construction), stone (crushed), stone (dimension).
Mississippi	110,079	42	.42	Sand and gravel (construction), clays, cement (portland), stone (crushed).
Missouri	863,041	10	3.28	Lead, cement (portland), stone (crushed), lime.
Montana	368,466	24	1.40	Gold, copper, silver, platinum-group metals.
Nebraska	89,748	43	.34	Cement (portland), sand and gravel (construction), stone (crushed), lime.
Nevada	1,446,814	3	5.49	Gold, silver, cement (portland), sand and gravel (construction).
New Hampshire[1]	54,680	47	.21	Sand and gravel (construction), stone (dimension), stone (crushed), gem stones.
New Jersey	214,224	35	.81	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), clays.
New Mexico	737,675	12	2.80	Copper, potassium salts, sand and gravel (construction), cement (portland).
New York	650,380	14	2.47	Stone (crushed), cement (portland), salt, sand and gravel (construction).
North Carolina	476,917	18	1.81	Stone (crushed), phosphate rock, lithium minerals, sand and gravel (construction).
North Dakota	26,311	48	.10	Lime, sand and gravel (construction), salt, stone (crushed).
Ohio	768,781	11	2.92	Stone (crushed), sand and gravel (construction), salt, lime.
Oklahoma	223,219	34	.85	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial).
Oregon	160,996	38	.61	Stone (crushed), sand and gravel (construction), cement (portland), lime.
Pennsylvania	1,016,496	9	3.86	Stone (crushed), cement (portland), lime, sand and gravel (construction).
Rhode Island[1]	18,698	49	.07	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gem stones.
South Carolina	341,325	27	1.30	Cement (portland), stone (crushed), clays, sand and gravel (construction).
South Dakota	262,892	33	1.00	Gold, cement (portland), sand and gravel (construction), stone (crushed).
Tennessee	527,812	16	2.00	Stone (crushed), zinc, cement (portland), sand and gravel (construction).
Texas	1,430,730	4	5.43	Cement (portland), stone (crushed), magnesium metal, sulfur (Frasch).

See footnotes at end of table.

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Table 3.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1987 —Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Utah	$699,964	13	2.66	Copper, gold, magnesium metal, sand and gravel (construction).
Vermont	72,444	45	.27	Stone (dimension), stone (crushed), sand and gravel (construction), talc.
Virginia	461,442	19	1.75	Stone (crushed), sand and gravel (construction), cement (portland), lime.
Washington	438,362	21	1.66	Magnesium metal, gold, sand and gravel (construction), cement (portland).
West Virginia	144,021	39	.55	Stone (crushed), cement (portland), salt, sand and gravel (construction).
Wisconsin	191,622	36	.73	Stone (crushed), sand and gravel (construction), lime, cement (portland).
Wyoming	645,055	15	2.45	Sodium carbonate (natural), clays, helium (Grade-A), stone (crushed).
Undistributed	6,553	--	.02	
Total[2]	26,346,000	XX	100.00	

XX Not applicable.
[1]Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.
[2]Data may not add to totals shown because of independent rounding.

Table 4.—Value of nonfuel mineral production per capita and per square mile in 1987, by State

State	Area (square miles)	Population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,705	4,053	$446,643	8,638	25	109	19
Alaska	591,004	525	125,280	212	50	239	10
Arizona	114,000	3,386	1,791,043	15,711	11	529	3
Arkansas	53,187	2,388	264,162	4,967	36	111	18
California	158,706	27,663	2,551,285	16,076	10	92	25
Colorado	104,091	3,296	372,990	3,583	38	113	16
Connecticut	5,018	3,211	122,275	24,367	3	38	45
Delaware	2,044	644	[1]6,401	3,132	43	10	50
Florida	58,664	12,023	1,346,237	22,948	5	112	17
Georgia	58,910	6,222	1,212,370	20,580	8	195	11
Hawaii	6,471	1,083	73,479	11,355	18	68	35
Idaho	83,564	998	269,373	3,226	41	270	6
Illinois	56,345	11,582	517,206	9,179	22	45	41
Indiana	36,185	5,531	363,865	10,056	21	66	36
Iowa	56,275	2,834	305,077	5,421	34	108	21
Kansas	82,277	2,476	319,604	3,884	37	129	15
Kentucky	40,409	3,727	290,335	7,185	28	78	29
Louisiana	47,751	4,461	424,221	8,884	24	95	24
Maine	33,265	1,184	65,457	1,968	46	55	39
Maryland	10,460	4,535	345,134	32,996	1	76	30
Massachusetts	8,284	5,855	176,522	21,309	7	30	47
Michigan	58,527	9,200	1,365,610	23,333	4	148	13
Minnesota	84,402	4,246	1,142,749	13,539	13	269	9
Mississippi	47,689	2,625	110,079	2,308	45	42	42
Missouri	69,697	5,103	863,041	12,383	17	169	12
Montana	147,046	809	368,466	2,506	44	455	5
Nebraska	77,355	1,594	89,748	1,160	48	56	38
Nevada	110,561	1,007	1,446,814	13,086	15	1,437	1
New Hampshire	9,279	1,057	[1]54,680	5,893	33	52	40
New Jersey	7,787	7,672	214,224	27,510	2	28	48
New Mexico	121,593	1,500	737,675	6,067	31	492	4
New York	49,107	17,825	650,380	13,244	14	36	46
North Carolina	52,669	6,413	476,917	9,055	23	74	32
North Dakota	70,703	672	26,311	372	49	39	44
Ohio	41,330	10,784	768,781	18,601	9	71	33
Oklahoma	69,956	3,272	223,219	3,191	42	68	34
Oregon	97,073	2,724	160,996	1,659	47	59	37
Pennsylvania	45,308	11,936	1,016,496	22,435	6	85	26
Rhode Island	1,212	986	[1]18,698	15,427	12	16	49
South Carolina	31,113	3,425	341,325	10,970	20	100	22
South Dakota	77,116	709	262,892	3,409	40	371	7
Tennessee	42,144	4,855	527,812	12,524	16	109	20
Texas	266,807	16,789	1,430,730	5,359	35	85	27
Utah	84,899	1,680	699,964	8,243	26	417	6
Vermont	9,614	548	72,444	7,535	27	132	14

See footnotes at end of table.

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Table 4.—Value of nonfuel mineral production per capita and per square mile in 1987, by State —Continued

State	Area (square miles)	Population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Virginia	40,767	5,904	$461,442	11,319	19	78	28
Washington	68,138	4,538	438,362	6,433	30	97	23
West Virginia	24,231	1,897	144,021	5,944	32	76	31
Wisconsin	56,153	4,807	191,622	3,412	39	40	43
Wyoming	97,809	490	645,055	6,595	29	1,316	2
Undistributed	XX	XX	6,553	XX	XX	XX	XX
Total[2] or average	3,618,700	242,744	e26,346,000	7,280	XX	109	XX

XX Not applicable.
[1]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data. Concealed values included with "Undistributed" figure.
[2]Excludes Washington, DC (which has no mineral production), with an area of 69 square miles and a population of 626,000.
[3]Data do not add to total shown because of independent rounding.

Table 5.—Nonfuel mineral production[1] in the United States, by State

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA						
Cement:						
Masonry thousand short tons	268	$18,113	267	$18,165	291	$17,626
Portland do	3,721	165,972	3,477	153,629	3,600	160,878
Clays[2] do	1,873	13,139	2,077	14,828	2,239	16,217
Gem stones	NA	e1	NA	1	NA	7
Lime thousand short tons	1,216	52,295	1,180	50,377	1,232	52,200
Sand and gravel:						
Construction do	e11,000	e32,000	10,781	30,807	e10,300	e35,600
Industrial do	524	4,533	433	3,388	580	5,025
Stone:						
Crushed do	25,853	109,176	e24,000	e120,500	30,018	146,247
Dimension do	10	2,661	e8	e968	W	W
Combined value of bauxite, clays (bentonite), salt, and value indicated by symbol W	XX	8,719	XX	12,553	XX	12,843
Total	XX	406,609	XX	405,216	XX	446,643
ALASKA						
Gem stones	NA	e$60	NA	$25	NA	$86
Gold (recoverable content of ores, etc.) troy ounces	44,733	14,210	48,271	17,775	86,548	38,769
Sand and gravel (construction) thousand short tons	e29,000	e63,000	27,762	61,954	e27,200	e73,400
Silver (recoverable content of ores, etc.) thousand troy ounces	W	W	W	W	10	70
Stone (crushed) thousand short tons	1,907	8,535	e2,000	e8,500	2,033	8,945
Combined value of cement (portland), tin, and values indicated by symbol W	XX	4,164	XX	3,226	XX	4,010
Total	XX	89,969	XX	91,480	XX	125,280
ARIZONA						
Clays thousand short tons	186	$1,503	201	$1,366	218	$1,905
Copper (recoverable content of ores, etc.) metric tons	796,556	1,175,995	789,175	1,149,193	764,148	1,389,771
Gem stones	NA	e2,700	NA	2,533	NA	3,000
Gold (recoverable content of ores, etc.) troy ounces	52,053	16,535	W	W	95,240	42,663
Gypsum thousand short tons	251	1,926	260	1,820	W	W
Lead (recoverable content of ores, etc.) metric tons	581	244	W	W	--	--
Lime thousand short tons	476	21,226	505	21,016	546	21,932
Molybdenum thousand pounds	24,125	63,389	29,382	75,607	W	W
Perlite short tons	W	W	W	W	49	1,361
Pumice thousand short tons	W	2	2	30	1	7
Sand and gravel (construction) do	e37,000	e118,000	40,468	140,004	e38,100	e141,300

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARIZONA—Continued						
Silver (recoverable content of ores, etc.) thousand troy ounces	4,885	$30,007	r4,506	r$24,649	3,667	$25,706
Stone (crushed) thousand short tons	5,929	23,111	e5,600	e25,100	7,712	33,999
Combined value of cement, pyrites (1985, 1987), salt (1986-87), sand and gravel (industrial), stone (dimension), and values indicated by symbol W	XX	95,447	XX	r118,505	XX	129,399
Total	XX	1,550,085	XX	r1,559,823	XX	1,791,043
ARKANSAS						
Clays thousand short tons	1,052	$10,769	2974	2$8,998	908	$8,651
Gem stones	NA	e200	NA	522	NA	1,800
Sand and gravel:						
Construction thousand short tons	e8,500	e24,400	8,571	26,999	e7,200	e23,900
Industrial do.	412	5,414	400	3,975	505	5,147
Stone:						
Crushed do.	14,815	60,874	e15,500	e58,500	15,234	63,847
Dimension do.	5	305	e5	e305	11	629
Combined value of abrasives,[3] bauxite, bromine, cement, clays (fire clay, 1986), gypsum, lime, talc, tripoli (1986-87), and vanadium (1985)	XX	168,290	XX	r163,703	XX	160,188
Total	XX	270,252	XX	r263,002	XX	264,162
CALIFORNIA						
Boron minerals thousand short tons	1,269	$404,775	1,251	$426,086	1,385	$475,092
Cement (portland) do.	9,462	601,506	9,490	578,502	9,937	593,859
Clays do.	2,203	26,600	2,449	33,289	2,296	33,045
Gem stones	NA	e550	NA	418	NA	3,367
Gold (recoverable content of ores, etc.) troy ounces	187,813	59,660	425,617	156,729	602,605	269,937
Gypsum thousand short tons	1,332	12,201	1,378	10,777	1,468	11,719
Lime do.	367	24,733	371	24,187	465	25,745
Mercury 76-pound flasks	--	--	--	--	(4)	(4)
Pumice thousand short tons	78	1,491	46	1,263	42	1,539
Sand and gravel:						
Construction do.	e112,800	e430,000	128,407	498,456	e141,600	e561,300
Industrial do.	2,255	37,434	2,364	44,813	2,241	41,472
Silver (recoverable content of ores, etc.) thousand troy ounces	115	709	155	849	122	854
Stone:						
Crushed thousand short tons	41,199	174,395	e38,500	e159,300	44,315	186,504
Dimension do.	23	2,449	e23	e2,582	33	4,554
Talc and pyrophyllite do.	100	2,493	64	1,528	W	W
Combined value of asbestos, barite (1987), calcium chloride (natural), cement (masonry), clays (ball clay, 1986, and fire clay, 1985), copper, diatomite, feldspar, iron ore (usable), magnesium compounds, molybdenum, peat, perlite, potassium salts, rare-earth metal concentrates, salt, sodium carbonate (natural), sodium sulfate (natural), tungsten ore and concentrate, wollastonite (1986-87), and value indicated by symbol W	XX	333,014	XX	330,638	XX	342,298
Total	XX	2,112,010	XX	2,269,417	XX	2,551,285

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
COLORADO						
Clays thousand short tons	303	$1,743	242	$1,523	292	$1,763
Gem stones	NA	e80	NA	100	NA	100
Gold (recoverable content of ores, etc.) troy ounces	43,301	13,755	120,347	44,317	178,795	80,091
Gypsum thousand short tons	233	1,800	W	W	W	W
Sand and gravel (construction) do.	e27,500	e88,000	23,233	70,095	e22,800	e84,300
Silver (recoverable content of ores, etc.) thousand troy ounces	549	3,370	645	3,526	861	6,033
Stone:						
Crushed thousand short tons	7,037	25,930	e8,000	e30,700	8,045	33,465
Dimension do.	2	204	e4	e255	3	133
Combined value of cement, copper, iron ore (usable, 1985), lead, lime, molybdenum, peat, perlite, pyrites (1985, 1987), sand and gravel (industrial), tin (1985), tungsten ore and concentrate (1985-86), vanadium, zinc, and values indicated by symbol W	XX	273,611	XX	219,492	XX	167,104
Total	XX	408,493	XX	370,008	XX	372,989
CONNECTICUT						
Clays thousand short tons	106	$632	157	$975	W	W
Gem stones	NA	W	NA	2	NA	$2
Sand and gravel (construction) thousand short tons	e6,000	e21,000	7,254	25,984	e8,400	e37,000
Stone:						
Crushed do.	7,277	43,937	e7,700	e45,800	11,412	76,668
Dimension do.	20	1,285	e24	e1,653	18	1,646
Combined value of feldspar, mica (scrap), sand and gravel (industrial), and values indicated by symbol W	XX	5,532	XX	6,040	XX	6,959
Total	XX	72,386	XX	80,454	XX	122,275
DELAWARE						
Gem stones	--	--	NA	$1	NA	$1
Marl (greensand) thousand short tons	2	$29	1	12	W	W
Sand and gravel (construction) do.	e1,300	e4,000	1,547	4,156	e2,300	e6,400
Total[5]	XX	4,029	XX	4,169	XX	6,401
FLORIDA						
Cement:						
Masonry thousand short tons	316	$17,137	352	$21,269	390	$24,069
Portland do.	3,282	148,908	3,189	147,643	3,565	165,944
Clays do.	672	33,074	726	43,261	598	39,496
Gem stones	NA	e6	NA	W	NA	W
Peat thousand short tons	243	5,333	365	5,743	363	6,068
Sand and gravel:						
Construction do.	e22,500	e49,500	28,233	67,898	e30,000	e74,900
Industrial do.	2,123	12,642	1,467	14,930	1,884	19,713
Stone (crushed) do.	69,266	287,237	e69,000	e288,200	e78,992	e350,587
Combined value of lime (1985-86), phosphate rock, rare-earth metal concentrates, staurolite, stone (crushed marl, 1987), titanium concentrates (ilmenite and rutile), zircon concentrates, and values indicated by symbol W	XX	1,007,899	XX	r700,919	XX	665,510
Total	XX	1,561,736	XX	r1,289,863	XX	1,346,237
GEORGIA						
Clays thousand short tons	8,671	$575,097	9,827	$669,200	10,455	$756,093
Gem stones	NA	e20	NA	20	NA	20

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
GEORGIA—Continued						
Sand and gravel:						
Construction thousand short tons	e5,000	e$13,400	8,126	$23,222	e9,000	e$26,900
Industrial do.	571	6,675	W	W	W	W
Stone:						
Crushed do.	52,062	256,588	e56,700	e293,100	60,834	318,903
Dimension do.	183	19,466	e199	e20,678	179	21,683
Talc do.	16	111	9	61	20	286
Combined value of barite, bauxite (1987), cement, feldspar, iron oxide pigments (crude), kyanite (1985-86), mica (scrap), peat, and values indicated by symbol W	XX	74,718	XX	85,174	XX	88,485
Total	XX	946,075	XX	1,091,455	XX	1,212,370
HAWAII						
Cement:						
Masonry thousand short tons	7	$588	7	$1,078	10	$1,559
Portland do.	215	16,050	287	24,253	324	26,550
Gem stones	NA	e25	NA	25	NA	25
Lime thousand short tons	W	W	3	W	3	W
Sand and gravel (construction) do.	e500	e2,100	605	2,666	e700	e3,500
Stone (crushed) do.	5,627	34,183	e7,100	e42,100	5,732	41,548
Combined value of other industrial minerals and values indicated by symbol W	XX	326	XX	290	XX	297
Total	XX	53,272	XX	70,412	XX	73,479
IDAHO						
Clays[2] thousand short tons	2	W	2	W	22	$230
Copper (recoverable content of ores, etc.) metric tons	3,551	$5,242	W	W	W	W
Gem stones	NA	e175	NA	$305	NA	507
Gold (recoverable content of ores, etc.) troy ounces	44,306	14,074	70,440	25,938	97,773	43,797
Lead (recoverable content of ores, etc.) metric tons	33,707	14,169	9,951	4,836	W	W
Lime thousand short tons	93	5,803	89	4,729	97	5,149
Phosphate rock thousand metric tons	3,784	104,000	r4,235	r82,332	3,411	47,072
Sand and gravel (construction) thousand short tons	e4,000	e11,400	5,708	14,830	e7,200	e28,000
Silver (recoverable content of ores, etc.) thousand troy ounces	18,828	115,645	11,207	61,301	W	W
Stone (crushed) thousand short tons	2,019	6,977	e3,700	e12,700	3,852	15,346
Zinc (recoverable content of ores, etc.) metric tons	W	W	351	294	W	W
Combined value of antimony (1985-86), cement, clays (bentonite, common clay, fire clay, and kaolin (1985-86)), garnet (abrasive), molybdenum, perlite, pumice, sand and gravel (industrial), stone (dimension), vanadium, and values indicated by symbol W	XX	81,181	XX	66,783	XX	129,272
Total	XX	358,666	XX	r274,048	XX	269,373
ILLINOIS						
Cement (portland) thousand short tons	2,101	$86,211	2,118	$83,783	2,119	$86,210
Clays[2] do.	265	876	283	1,092	233	977
Gem stones	NA	e15	NA	15	NA	15
Sand and gravel:						
Construction thousand short tons	e26,600	e77,000	27,867	82,523	e28,300	e93,300
Industrial do.	4,056	56,915	4,039	52,133	4,346	45,547
Stone:						
Crushed do.	41,044	164,117	e44,200	e179,600	52,102	216,212
Dimension do.	2	107	e2	e107	W	W
Combined value of barite (1985), cement (masonry), clays (fuller's earth), copper, fluorspar, lead, lime, peat, silver, tripoli, zinc, and value indicated by symbol W	XX	74,679	XX	70,272	XX	74,945
Total	XX	459,920	XX	469,525	XX	517,206

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985 Quantity	1985 Value (thousands)	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
INDIANA						
Cement:						
Masonry thousand short tons	W	W	395	$22,936	422	$32,299
Portland do	W	W	2,136	92,327	2,320	103,177
Clays do	740	$2,776	744	3,044	[2]1,037	[2]4,056
Gem stones	NA	[e]1	NA	1	NA	10
Peat thousand short tons	54	W	79	W	44	W
Sand and gravel:						
Construction do	[e]18,600	[e]55,800	19,642	61,232	[e]18,900	[e]65,200
Industrial do	182	1,209	193	1,490	230	1,357
Stone:						
Crushed do	[e]23,384	[e]81,119	[e] [e]22,600	[e] [e]76,500	31,067	106,770
Dimension do	169	20,186	[e]191	[e]20,252	184	23,115
Combined value of abrasives, clays (fire clay, 1987), gypsum, lime, stone (crushed marl, 1985-86), and values indicated by symbol W	XX	141,863	XX	27,566	XX	27,881
Total	XX	302,954	XX	305,348	XX	363,865
IOWA						
Cement:						
Masonry thousand short tons	39	$3,372	48	$3,199	W	W
Portland do	1,618	77,890	1,819	86,984	2,139	$104,457
Clays do	503	2,450	486	1,421	473	1,495
Gem stones	NA	[e]1	NA	20	NA	W
Gypsum thousand short tons	1,639	13,682	1,826	12,602	1,874	12,837
Peat do	11	415	14	381	24	W
Sand and gravel (construction) do	[e]12,000	[e]30,500	14,511	40,418	[e]19,000	[e]63,800
Stone (crushed) do	23,657	94,496	[e]23,400	[e]98,000	25,991	110,106
Combined values of other industrial minerals and values indicated by symbol W	XX	5,211	XX	5,707	XX	12,332
Total	XX	228,017	XX	248,732	XX	305,077
KANSAS						
Cement:						
Masonry thousand short tons	W	W	51	$3,264	52	$3,150
Portland do	W	W	1,763	91,110	1,697	81,045
Clays do	878	$5,326	903	5,295	[2]604	[2]2,576
Gem stones	NA	[e]1	NA	3	NA	3
Salt[3] thousand short tons	1,790	71,970	1,656	68,887	1,689	70,148
Sand and gravel:						
Construction do	[e]13,200	[e]31,800	15,609	33,721	[e]15,600	[e]37,800
Industrial do	134	1,124	132	1,155	127	1,400
Stone:						
Crushed do	15,653	57,155	[e]16,600	[e]60,300	19,319	69,628
Dimension do	W	W	W	W	11	445
Combined value of clays (bentonite, 1987), gypsum, helium (crude and Grade-A), pumice, salt (brine), and values indicated by symbol W	XX	154,793	XX	53,910	XX	53,409
Total	XX	322,169	XX	317,645	XX	319,604
KENTUCKY						
Clays thousand short tons	775	$6,487	[2]721	[2]$3,450	1,031	$8,821
Gem stones	NA	[e]1	NA	3	NA	3
Sand and gravel (construction) thousand short tons	[e]7,600	[e]19,000	7,194	16,986	[e]7,100	[e]15,200
Stone (crushed) do	[e]38,022	[e]134,978	[e] [e]38,400	[e] [e]137,000	43,330	173,222
Zinc metric tons	W	W	W	W	10	9
Combined value of cement, clays (ball clay and fire clay, 1986), lime, sand and gravel (industrial), stone (crushed sandstone, 1985-86), and values indicated by symbol W	XX	107,092	XX	109,826	XX	93,080
Total	XX	267,558	XX	267,265	XX	290,385

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
LOUISIANA						
Clays thousand short tons	334	$7,017	332	$7,670	357	$9,192
Gem stones	NA	e1	NA	1	NA	1
Salt thousand short tons	12,271	137,273	11,608	103,611	12,498	108,999
Sand and gravel:						
Construction do.	e15,000	e48,000	14,292	46,134	e12,200	e43,600
Industrial do.	267	3,838	256	4,225	289	3,997
Stone (crushed)[6] do.	4,820	25,956	e5,400	e25,300	4,390	36,514
Sulfur (Frasch) thousand metric tons	1,698	W	1,602	W	1,458	W
Combined value of cement (masonry (1985, 1987), and portland), gypsum (1985, 1987), lime, stone (crushed miscellaneous), and values indicated by symbol W	XX	298,501	XX	259,857	XX	221,918
Total	XX	520,586	XX	446,798	XX	424,221
MAINE						
Clays thousand short tons	50	$100	46	$90	W	W
Gem stones	NA	e400	NA	200	NA	$1,172
Sand and gravel (construction) thousand short tons	e7,200	e18,000	8,572	22,843	e8,600	e22,100
Stone:						
Crushed do.	1,459	5,114	e1,600	e4,400	2,010	7,532
Dimension do.	W	W	W	W	8	5,924
Combined value of cement, garnet (abrasive), peat (1986), and values indicated by symbol W	XX	17,494	XX	25,326	XX	28,729
Total	XX	41,108	XX	52,859	XX	65,457
MARYLAND						
Cement (portland) thousand short tons	W	W	1,785	$89,799	1,829	$90,020
Clays do.	r2336	r2$1,647	r2362	r21,757	383	1,940
Gem stones	NA	e2	NA	5	NA	5
Lime thousand short tons	10	608	10	546	9	486
Sand and gravel (construction) do.	e17,000	e58,000	18,173	86,925	e19,600	e92,900
Stone:						
Crushed do.	24,406	98,584	e26,400	e126,000	30,136	151,579
Dimension do.	18	1,218	e21	e1,286	23	1,516
Combined value of cement (masonry), clays (ball clay, 1985-86), peat, sand and gravel (industrial), and value indicated by symbol W	XX	98,215	XX	7,027	XX	6,688
Total	XX	258,274	XX	313,345	XX	345,134
MASSACHUSETTS						
Clays thousand short tons	265	$1,388	140	$871	W	W
Gem stones	NA	W	NA	W	NA	$1
Lime do.	159	10,935	W	W	W	W
Sand and gravel:						
Construction do.	e14,900	e47,500	19,200	60,464	e21,800	e75,300
Industrial do.	W	W	45	739	56	922
Stone:						
Crushed do.	9,354	42,881	e10,000	e50,000	14,907	78,969
Dimension do.	73	13,724	e79	e14,928	77	12,747
Combined value of peat and values indicated by symbol W	XX	777	XX	7,395	XX	8,583
Total	XX	117,205	XX	134,397	XX	176,522
MICHIGAN						
Cement:						
Masonry thousand short tons	W	W	257	$17,026	263	$23,004
Portland do.	W	W	4,713	216,120	4,755	207,332
Clays do.	1,477	$5,514	1,402	5,684	1,333	5,338
Gem stones	NA	e15	NA	25	NA	25
Gypsum thousand short tons	1,772	11,883	1,979	11,052	1,977	12,190
Iron ore (usable) thousand long tons, gross weight	12,629	W	10,957	W	12,312	W

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MICHIGAN—Continued						
Lime thousand short tons	535	$24,790	556	$27,257	569	$30,320
Peat do.	282	5,414	r324	r6,599	281	5,290
Salt do.	927	71,224	W	W	W	W
Sand and gravel:						
Construction do.	e38,000	e93,000	42,514	91,886	e42,800	e105,300
Industrial do.	3,345	25,469	3,343	29,493	2,792	22,451
Stone:						
Crushed do.	30,685	95,953	e27,800	e83,900	37,909	109,514
Dimension do.	4	113	e6	e148	W	W
Combined value of bromine, calcium chloride (natural), copper, gold, iodine (1985), iron oxide pigments (crude), magnesium compounds, silver, and values indicated by symbol W	XX	1,053,672	XX	r750,393	XX	844,845
Total	XX	1,387,047	XX	r1,239,583	XX	1,365,610
MINNESOTA						
Gem stones	NA	e$5	NA	$5	NA	$40
Iron ore (usable) thousand long tons, gross weight	34,977	1,430,353	28,779	1,017,261	33,654	1,012,788
Peat thousand short tons	34	1,720	W	W	30	W
Sand and gravel:						
Construction do.	e25,000	e55,500	24,055	53,116	e25,200	e67,400
Industrial do.	884	16,910	W	W	W	W
Stone:						
Crushed do.	7,756	22,601	e8,300	e26,300	8,995	29,246
Dimension do.	37	13,598	e28	e10,507	41	12,967
Combined value of clays, lime, and values indicated by symbol W	XX	r7,272	XX	20,438	XX	20,308
Total	XX	r1,547,959	XX	1,127,627	XX	1,142,749
MISSISSIPPI						
Clays thousand short tons	1,558	$34,864	2928	2$13,538	1,123	$26,933
Gem stones	--	--	NA	1	NA	1
Sand and gravel (construction) thousand short tons	e13,400	e42,000	15,080	42,809	e14,700	e47,000
Stone (crushed) do.	1,582	4,282	e1,600	e4,400	1,492	9,621
Combined value of cement, clays (ball clay and fuller's earth, 1986), and sand and gravel (industrial)	XX	21,647	XX	40,347	XX	26,524
Total	XX	102,793	XX	101,095	XX	110,079
MISSOURI						
Barite thousand short tons	47	$2,791	W	W	27	$2,030
Cement:						
Masonry do.	139	6,630	167	$7,816	167	10,027
Portland do.	3,669	159,757	4,642	179,184	5,110	185,317
Clays[2] do.	1,545	10,271	1,321	6,650	1,476	10,415
Copper (recoverable content of ores, etc.) metric tons	13,410	19,797	W	W	W	W
Gem stones	NA	e10	NA	W	NA	W
Iron ore (usable) thousand long tons, gross weight	1,110	W	803	W	744	W
Lead (recoverable content of ores, etc.) metric tons	371,008	155,955	319,900	155,481	W	W
Sand and gravel:						
Construction thousand short tons	e7,500	e20,000	9,746	24,065	e10,900	e30,400
Industrial do.	535	7,330	517	6,230	622	7,786
Silver (recoverable content of ores, etc.) thousand troy ounces	1,635	10,044	1,459	7,982	1,181	8,276
Stone:						
Crushed thousand short tons	50,646	162,097	e51,200	e170,500	54,910	184,824
Dimension do.	W	W	W	W	3	454
Zinc (recoverable content of ores, etc.) metric tons	49,340	43,908	37,919	31,767	34,956	32,306
Combined value of clays (fuller's earth), iron oxide pigments (crude), lime, and values indicated by symbol W	XX	136,370	XX	158,910	XX	391,206
Total	XX	734,960	XX	748,585	XX	863,041

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MONTANA						
Clays thousand short tons	279	$8,296	222	$5,882	[2]29	[2]$98
Copper (recoverable content of ores, etc.) metric tons	15,092	22,281	W	W	W	W
Gem stones	NA	400	NA	480	NA	1,302
Gold (recoverable content of ores, etc.) troy ounces	160,262	50,909	W	W	234,365	104,984
Gypsum thousand short tons	W	W	W	W	24	W
Lead (recoverable content of ores, etc.) metric tons	846	356	W	W	W	W
Sand and gravel (construction) thousand short tons	e9,000	e26,000	8,066	19,391	e6,800	e18,800
Silver (recoverable content of ores, etc.) thousand troy ounces	4,010	24,630	4,773	26,110	5,837	40,920
Stone (crushed) thousand short tons	e1,730	e5,044	e e2,200	e e6,200	1,463	3,585
Talc do.	W	W	W	W	386	12,321
Combined value of barite (1985, 1987), cement, clays (fire clay, 1987), iron ore (usable), lime, molybdenum (1986-87), peat, phosphate rock, platinum-group metals (1987), sand and gravel (industrial), stone (crushed traprock, 1985-86, and, dimension), vermiculite, zinc (1987), and values indicated by symbol W	XX	r62,366	XX	r179,870	XX	186,456
Total	XX	r200,282	XX	r237,933	XX	368,466
NEBRASKA						
Clays thousand short tons	244	$718	221	$668	224	$721
Gem stones	NA	e10	NA	10	NA	10
Sand and gravel (construction) thousand short tons	e11,600	e28,800	9,675	23,912	e10,300	e26,300
Stone (crushed) do.	4,175	19,134	e4,000	e17,900	4,316	19,461
Combined value of cement, lime, and sand and gravel (industrial)	XX	51,308	XX	51,598	XX	43,256
Total	XX	99,970	XX	94,088	XX	89,748
NEVADA						
Barite thousand short tons	590	$10,904	184	$3,005	308	$4,778
Clays do.	[2]80	[2]3,776	[2]10	[2]584	65	2,468
Gem stones	NA	e1,300	NA	213	NA	280
Gold (recoverable content of ores, etc.) troy ounces	1,276,114	405,369	r2,098,980	r772,909	2,679,470	1,200,269
Gypsum thousand short tons	1,207	8,942	1,236	8,221	W	W
Lead (recoverable content of ores, etc.) metric tons	([4])	([4])	—	—	—	—
Mercury 76-pound flasks	16,530	W	—	—	—	—
Perlite short tons	W	W	4	122	W	W
Sand and gravel:						
Construction thousand short tons	e9,500	e24,880	12,197	35,692	e10,600	e30,700
Industrial do.	479	W	518	W	578	W
Silver (recoverable content of ores, etc.) thousand troy ounces	4,947	30,383	6,409	35,056	12,190	85,451
Stone (crushed) thousand short tons	1,334	6,218	e1,500	e7,000	e1,264	e5,700
Combined value of cement (portland), clays (fuller's earth and kaolin, 1985-86), copper (1985-86), diatomite, fluorspar, iron ore (usable, 1985-86), lime, lithium minerals, magnesite, molybdenum (1985), salt, stone (crushed dolomite, 1987), and values indicated by symbol W	XX	139,201	XX	114,529	XX	117,168
Total	XX	630,973	XX	r977,350	XX	1,446,814
NEW HAMPSHIRE						
Gem stones	NA	W	NA	W	NA	$310
Sand and gravel (construction) thousand short tons	e6,300	e$19,800	8,418	$26,089	e9,100	e33,300
Stone:						
Crushed do.	1,612	6,434	e1,800	e5,900	2,479	10,386
Dimension do.	80	6,625	e82	e6,451	67	10,684
Combined value of other industrial minerals and values indicated by symbol W	XX	134	XX	137	XX	([7])
Total	XX	32,993	XX	38,577	XX	[5]54,680

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW JERSEY						
Clays thousand short tons	130	$2,050	133	$2,066	[2]6	[2]$140
Gem stones	NA	[e]1	NA	3	NA	3
Peat thousand short tons	W	311	W	542	32	614
Sand and gravel:						
Construction do.	[e]10,600	[e]36,700	13,999	53,746	[e]15,200	[e]61,200
Industrial do.	2,820	31,119	2,341	29,878	2,112	27,872
Stone (crushed) do.	15,692	94,339	[e]15,300	[e]95,400	[e]17,576	[e]111,951
Combined value of other industrial minerals	XX	13,056	XX	4,613	XX	12,444
Total	XX	177,576	XX	186,248	XX	214,224
NEW MEXICO						
Clays thousand short tons	60	$161	60	$170	51	$141
Gem stones	NA	[e]200	NA	200	NA	200
Gold (recoverable content of ores, etc.) troy ounces	45,045	14,309	39,856	14,677	W	W
Gypsum thousand short tons	350	1,570	W	W	W	W
Lead (recoverable content of ores, etc.) metric tons	W	W	10	5	W	W
Perlite thousand short tons	430	14,896	433	13,727	437	13,611
Potassium salts thousand metric tons	1,120	156,000	987	[r]132,900	1,323	174,200
Pumice thousand short tons	152	1,114	255	2,370	87	991
Sand and gravel (construction) do.	[e]8,400	[e]22,800	8,471	25,862	[e]8,600	[e]31,000
Stone:						
Crushed do.	3,641	15,232	[e]3,900	[e]15,300	4,503	15,919
Dimension do.	20	277	[e]22	[e]378	22	626
Combined value of cement, copper, helium (Grade-A), iron ore (usable, 1986-87), mica (scrap), molybdenum, pyrites (1987), salt, silver, and values indicated by symbol W	XX	430,705	XX	406,586	XX	500,987
Total	XX	657,264	XX	[r]612,175	XX	737,675
NEW YORK						
Clays thousand short tons	700	$3,129	619	$3,075	678	$3,562
Emery short tons	W	W	2,878	W	1,945	W
Gem stones	NA	[e]30	NA	100	NA	135
Peat thousand short tons	W	W	W	W	1	34
Salt do.	7,044	142,318	5,071	122,601	4,918	119,962
Sand and gravel:						
Construction do.	[e]28,000	[e]88,500	31,172	103,748	[e]31,400	[e]112,900
Industrial do.	W	W	59	1,164	58	651
Stone:						
Crushed do.	35,139	165,136	[e]40,600	[e]196,600	38,103	188,694
Dimension do.	16	3,666	[e]16	[e]3,002	39	5,822
Combined value of cement, garnet (abrasive), gypsum, lead, lime (1985), silver, talc, wollastonite, zinc, and values indicated by symbol W	XX	254,529	XX	247,272	XX	218,620
Total	XX	657,308	XX	677,562	XX	650,380
NORTH CAROLINA						
Clays thousand short tons	2,688	$10,477	2,658	$10,970	3,229	$15,282
Feldspar short tons	490,993	13,351	526,672	15,568	512,386	15,562
Gem stones	NA	[e]50	NA	551	NA	550
Gold (recoverable content of ores, etc.) troy ounces	--	--	12	4	--	--
Mica (scrap) thousand short tons	80	3,726	89	4,641	100	5,607
Peat do.	W	W	15	W	W	W
Sand and gravel:						
Construction do.	[e]6,100	[e]19,500	7,543	23,127	[e]8,600	[e]30,100
Industrial do.	1,294	13,086	1,464	16,656	1,184	15,329
Stone:						
Crushed do.	41,771	194,818	[e]43,500	[e]206,500	48,847	237,181
Dimension do.	35	6,132	[e]41	[e]6,633	33	5,128

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985 Quantity	1985 Value (thousands)	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
NORTH CAROLINA—Continued						
Talc and pyrophyllite thousand short tons	885	$1,604	83	$1,552	W	W
Combined value of lithium minerals, olivine, phosphate rock, and values indicated by symbol W	XX	r203,442	XX	r180,528	XX	$152,178
Total	XX	r466,186	XX	r466,730	XX	476,917
NORTH DAKOTA						
Clays thousand short tons	W	W	W	W	50	$100
Gem stones	NA	e$2	NA	$2	NA	2
Lime thousand short tons	56	5,562	74	7,359	127	11,912
Sand and gravel (construction) do.	e6,900	e13,800	5,135	10,741	e4,900	e10,200
Combined value of peat, salt, sand and gravel (industrial, 1986-87), stone (crushed miscellaneous), and values indicated by symbol W	XX	4,820	XX	2,700	XX	4,097
Total	XX	24,184	XX	20,802	XX	26,311
OHIO						
Cement:						
Masonry thousand short tons	110	$10,412	138	$11,540	139	$11,964
Portland do.	1,769	84,929	1,706	79,383	1,748	83,661
Clays do.	2,114	10,581	2,833	11,515	3,187	12,714
Gem stones	NA	e10	NA	10	NA	10
Lime thousand short tons	1,730	84,142	1,648	81,103	1,926	93,108
Peat do.	16	413	6	W	W	W
Salt do.	4,329	130,964	4,115	126,757	3,276	104,099
Sand and gravel:						
Construction do.	e33,000	e109,000	36,806	126,747	e36,400	e136,900
Industrial do.	1,312	21,945	1,221	21,183	1,249	21,292
Stone:						
Crushed do.	38,310	136,544	e39,300	e147,300	51,590	300,096
Dimension do.	53	3,661	e36	e2,708	48	2,427
Combined value of abrasives, gypsum, and values indicated by symbol W	XX	1,541	XX	1,738	XX	2,510
Total	XX	594,142	XX	609,984	XX	768,781
OKLAHOMA						
Cement:						
Masonry thousand short tons	43	$2,854	50	$3,198	41	$2,436
Portland do.	1,589	72,583	1,579	69,075	1,415	54,870
Clays do.	997	2,338	993	2,329	797	1,783
Gem stones	NA	e2	NA	2	NA	8
Gypsum thousand short tons	1,595	12,548	1,683	9,855	1,828	13,336
Sand and gravel:						
Construction do.	e12,600	e32,300	10,366	24,585	e10,500	e24,200
Industrial do.	W	W	1,203	16,454	1,243	17,078
Stone:						
Crushed do.	31,173	98,811	e30,900	e102,100	e25,155	e83,732
Dimension do.	11	836	e19	e913	8	861
Combined value of feldspar, iodine, lime, pumice (1985-86), salt, stone (crushed dolomite, 1987), tripoli, and value indicated by symbol W	XX	29,335	XX	18,504	XX	24,915
Total	XX	251,607	XX	247,015	XX	223,219
OREGON						
Clays thousand short tons	188	$285	204	$289	268	$986
Gem stones	NA	e350	NA	350	NA	350
Nickel (content of ore and concentrate) short tons	6,127	W	1,175	W	--	--
Sand and gravel (construction) thousand short tons	e12,500	e36,800	13,441	42,597	e13,000	e42,200
Stone (crushed) do.	15,336	54,244	e15,100	e53,400	20,663	73,902
Talc (soapstone) do.	(4)	30	(4)	41	(4)	14
Combined value of cement, diatomite, gold, lime, pumice, silver (1987), stone (dimension, 1985-86), and values indicated by symbol W	XX	38,587	XX	29,755	XX	43,544
Total	XX	130,296	XX	126,432	XX	160,996

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
PENNSYLVANIA						
Cement:						
Masonry ____ thousand short tons	303	$20,970	391	$26,683	397	$30,464
Portland ____ do ____	5,535	288,036	6,290	324,187	6,325	334,709
Clays[2] ____ do ____	1,142	5,293	1,234	5,061	1,206	4,751
Gem stones ____	NA	e5	NA	5	NA	5
Lime ____ thousand short tons	1,492	85,269	1,417	81,234	1,574	93,430
Peat ____ do ____	21	602	19	532	18	513
Sand and gravel:						
Construction ____ do ____	e17,000	e74,000	15,373	68,880	e14,800	e72,900
Industrial ____ do ____	693	9,846	688	10,091	W	W
Stone:						
Crushed ____ do ____	64,765	310,859	e63,700	e317,100	97,213	458,676
Dimension ____ do ____	51	8,214	e72	e8,100	60	10,177
Combined value of clays (kaolin), mica (scrap), tripoli (1986-87), and value indicated by symbol W ____	XX	1,380	XX	1,185	XX	10,871
Total ____	XX	804,474	XX	843,058	XX	1,016,496
RHODE ISLAND						
Gem stones ____	NA	W	NA	W	NA	$1
Sand and gravel:						
Construction ____ thousand short tons	e1,200	e$4,600	2,269	$8,252	e2,700	e10,900
Industrial ____ do ____	W	W	22	143	W	W
Stone (crushed) ____ do ____	e1,135	e7,016	e e1,000	e e5,700	1,228	7,797
Combined value of other industrial minerals and values indicated by symbol W ____	XX	576	XX	101	XX	(7)
Total ____	XX	12,192	XX	14,196	XX	518,698
SOUTH CAROLINA						
Cement (portland) ____ thousand short tons	2,207	$104,705	2,306	$109,529	2,567	$117,878
Clays[2] ____ do ____	1,896	37,695	1,986	37,980	2,193	38,244
Gem stones ____	NA	e10	NA	10	NA	10
Manganiferous ore ____ short tons	19,882	W	14,320	W	19,087	W
Peat ____ thousand short tons	W	173	W	W	W	W
Sand and gravel:						
Construction ____ do ____	e4,900	e14,000	7,200	19,783	e7,500	e19,500
Industrial ____ do ____	794	14,092	800	14,081	844	15,188
Stone:						
Crushed ____ do ____	17,079	72,520	e18,200	e76,700	e24,278	e105,387
Dimension ____ do ____	8	541	e8	e533	2	312
Combined value of cement (masonry), clays (fuller's earth), gold, mica (scrap), silver, stone (crushed shell, 1987), vermiculite, and values indicated by symbol W ____	XX	32,193	XX	37,273	XX	44,806
Total ____	XX	275,929	XX	295,889	XX	341,325
SOUTH DAKOTA						
Cement:						
Masonry ____ thousand short tons	4	W	4	W	4	W
Portland ____ do ____	655	W	635	W	519	W
Clays[2] ____ do ____	117	$309	119	$375	W	W
Feldspar ____ short tons	13,721	W	W	W	W	W
Gem stones ____	NA	e70	NA	100	NA	$100
Gold (recoverable content of ores, etc.) troy ounces	356,103	113,119	W	W	W	W
Gypsum ____ thousand short tons	34	269	31	268	W	W
Sand and gravel (construction) ____ do ____	e6,400	e16,000	9,713	19,853	e9,600	e19,100
Silver (recoverable content of ores, etc.) thousand troy ounces	63	388	W	W	W	W
Stone:						
Crushed ____ thousand short tons	4,071	14,412	e3,600	e12,600	5,070	18,515
Dimension ____ do ____	51	18,336	e55	e18,399	51	18,209
Combined value of beryllium concentrates, clays (bentonite, 1985-86; common, 1987), lime, mica (scrap), and values indicated by symbol W ____	XX	44,800	XX	181,291	XX	206,968
Total ____	XX	207,703	XX	232,886	XX	262,892

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
TENNESSEE						
Clays[2] thousand short tons	1,244	$25,913	1,164	$25,228	1,261	$25,480
Gem stones	NA	e5	NA	W	NA	W
Phosphate rock thousand metric tons	1,233	27,000	r1,231	r21,191	W	W
Sand and gravel:						
Construction thousand short tons	e7,200	e22,000	7,360	24,592	e7,900	e28,900
Industrial do.	569	6,156	488	5,523	W	W
Stone:						
Crushed do.	e37,939	e155,760	e e40,700	e e175,600	51,406	227,263
Dimension do.	6	1,856	e6	e1,553	3	573
Zinc (recoverable content of ores, etc.) metric tons	104,471	92,971	102,118	85,550	115,699	106,926
Combined value of barite, cement, clays (fuller's earth), copper, lead (1985, 1987), lime, pyrites, silver, stone (crushed granite, 1985-86), and values indicated by symbol W	XX	141,109	XX	136,610	XX	138,670
Total	XX	r473,270	XX	r475,847	XX	527,812
TEXAS						
Cement:						
Masonry thousand short tons	263	$22,114	209	$15,790	172	$11,283
Portland do.	10,242	532,494	8,883	412,697	7,318	319,996
Clays do.	4,107	28,059	r2,515	r11,724	3,475	25,959
Gem stones	NA	e175	NA	297	NA	345
Gypsum thousand short tons	1,981	17,299	2,131	14,982	1,874	14,254
Lime do.	1,192	65,927	1,173	62,670	1,140	59,027
Salt do.	8,390	84,249	8,520	62,996	7,810	60,857
Sand and gravel:						
Construction do.	e57,800	e198,000	59,562	209,855	e48,200	e178,600
Industrial do.	1,968	29,095	1,302	18,274	1,509	22,843
Stone:						
Crushed do.	85,764	306,821	e84,200	e301,500	84,347	276,477
Dimension do.	36	11,209	e49	e15,407	75	10,030
Sulfur (Frasch) thousand metric tons	2,979	W	2,506	W	2,152	W
Talc thousand short tons	261	5,245	283	6,456	255	4,380
Combined value of asphalt (native, 1985-86), clays (ball clay, fuller's earth, and kaolin, 1986), fluorspar (1985-86), helium (crude and Grade-A), iron ore (usable), magnesium chloride (1985), magnesium compounds, magnesium metal (1986-87), mica (scrap, 1985), sodium sulfate (natural), and values indicated by symbol W	XX	435,936	XX	579,340	XX	446,679
Total	XX	1,736,623	XX	1,711,988	XX	1,430,730
UTAH						
Beryllium concentrates short tons	5,738	$6	6,533	$7	6,062	$6
Cement (portland) thousand short tons	W	W	1,014	58,431	935	50,565
Clays do.	332	2,509	305	2,048	315	1,959
Gem stones	NA	e80	NA	96	NA	105
Gold (recoverable content of ores, etc.) troy ounces	135,489	43,039	W	W	W	W
Gypsum thousand short tons	r274	r2,942	r284	r2,478	W	W
Lime do.	225	11,912	232	13,079	562	17,894
Salt do.	1,057	30,013	1,112	31,830	1,108	34,264
Sand and gravel:						
Construction do.	e14,000	e36,400	16,452	39,763	e21,000	e56,700
Industrial do.	W	W	6	123	6	11
Stone:						
Crushed do.	4,657	14,180	e4,500	e14,100	7,989	23,606
Dimension do.	W	W	W	W	2	93
Vermiculite do.	--	--	W	153	--	--
Combined value of asphalt (native, 1985-86), cement (masonry), copper, iron ore (usable, 1986-87), magnesium compounds, magnesium metal (1986-87), mercury (1986-87), molybdenum (1985, 1987), phosphate rock, potassium salts, silver, sodium sulfate (natural, 1985-86), vanadium (1986-87), and values indicated by symbol W	XX	171,792	XX	r212,330	XX	514,661
Total	XX	r312,873	XX	r374,438	XX	699,864

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
VERMONT						
Gem stones	NA	W	NA	W	NA	$10
Sand and gravel (construction) thousand short tons	e2,700	e$7,000	4,834	$11,226	e4,700	e10,800
Stone:						
Crushed do.	1,689	7,468	e1,600	e7,600	e2,159	e20,400
Dimension do.	116	26,346	e105	e27,075	104	30,074
Combined value of asbestos, stone (crushed granite, 1987), talc, and values indicated by symbol W	XX	9,040	XX	9,310	XX	11,160
Total	XX	49,854	XX	55,211	XX	72,444
VIRGINIA						
Clays thousand short tons	814	$6,977	890	$7,700	r1,171	r$6,291
Gem stones	NA	e20	NA	20	NA	20
Iron oxide pigments (crude) short tons	2,280	W	W	W	W	W
Lime thousand short tons	633	28,103	624	27,362	699	29,435
Sand and gravel (construction) do.	e10,200	e42,000	11,670	46,488	e12,100	e43,400
Stone:						
Crushed do.	51,686	221,900	e52,000	e224,700	60,376	295,903
Dimension do.	10	3,136	e10	e3,128	9	2,720
Combined value of aplite, cement, clays (fuller's earth, 1987), gypsum, kyanite, sand and gravel (industrial), talc (soapstone, 1985, 1987), vermiculite, and values indicated by symbol W	XX	79,140	XX	83,639	XX	83,673
Total	XX	381,276	XX	393,037	XX	461,442
WASHINGTON						
Cement:						
Masonry thousand short tons	W	W	6	$530	W	W
Portland do.	W	W	1,212	59,091	1,282	$63,600
Clays do.	243	$1,402	252	1,560	416	2,356
Gem stones	NA	e200	NA	200	NA	200
Peat thousand short tons	12	292	W	W	7	191
Sand and gravel:						
Construction do.	e22,700	e62,300	26,342	76,387	e25,300	e78,900
Industrial do.	322	5,589	W	W	294	5,186
Stone:						
Crushed do.	9,543	31,052	e9,000	e34,100	14,754	49,618
Dimension do.	1	53	e1	e69	(4)	42
Combined value of barite (1985), calcium chloride (natural), copper (1987), diatomite, gold, gypsum, lime, magnesium metal (1986-87), olivine, silver, and values indicated by symbol W	XX	120,719	XX	204,688	XX	238,269
Total	XX	221,607	XX	376,625	XX	438,362
WEST VIRGINIA						
Clays thousand short tons	331	$3,342	215	$470	266	$565
Gem stones	--	--	NA	1	NA	1
Salt thousand short tons	895	W	W	W	W	W
Sand and gravel (construction) do.	e900	e3,000	1,501	5,365	e1,000	e3,200
Stone (crushed) do.	9,393	38,348	e9,800	e37,500	12,458	50,947
Combined value of cement, lime (1985, 1987), peat, sand and gravel (industrial), and values indicated by symbol W	XX	60,719	XX	86,473	XX	89,308
Total	XX	105,409	XX	129,809	XX	144,021
WISCONSIN						
Gem stones	--	--	NA	$15	NA	$15
Lime thousand short tons	341	$19,001	350	19,715	393	21,733
Peat do.	10	W	9	W	9	W
Sand and gravel:						
Construction do.	e16,000	e36,000	24,913	59,325	e23,900	e57,000
Industrial do.	1,197	14,624	1,194	12,399	1,314	15,168

See footnotes at end of table.

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Table 5.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1985 Quantity	1985 Value (thousands)	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
WISCONSIN—Continued						
Stone:						
Crushed thousand short tons	14,496	$42,380	e18,700	e$57,600	622,757	6$71,776
Dimension do	22	2,733	e23	e2,878	37	3,697
Combined value of abrasives, cement, stone (crushed traprock, 1987), and values indicated by symbol W	XX	10,372	XX	12,600	XX	22,233
Total	XX	125,110	XX	164,532	XX	191,622
WYOMING						
Clays thousand short tons	2,302	$64,146	1,762	$51,823	22,128	2$62,031
Gem stones	NA	225	NA	225	NA	150
Gypsum thousand short tons	r404	r3,135	W	W	W	W
Lime do	W	W	25	1,689	29	1,560
Sand and gravel (construction) do	e3,500	e11,000	3,377	10,977	e2,600	e9,000
Stone (crushed) do	62,030	67,329	e e61,700	e e65,900	3,171	15,049
Combined value of beryllium concentrates (1986), cement (masonry, 1986-87, and portland), clays (common, 1987), helium (Grade-A, 1986-87), sodium carbonate (natural), stone (crushed granite, 1985-86), and values indicated by symbol W	XX	465,275	XX	r484,196	XX	557,265
Total	XX	r551,110	XX	r554,810	XX	645,055

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" figure.

[3]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

[4]Less than 1/2 unit.

[5]Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

[6]Excludes certain stones; value included with "Combined value" figure.

[7]Value excluded to avoid disclosing company proprietary data.

Table 6.—Mineral production[1] in the islands administered by the United States

(Thousand short tons and thousand dollars)

Area and mineral	1985 Quantity	1985 Value	1986 Quantity	1986 Value	1987 Quantity	1987 Value
American Samoa: Stone	(2)	1	(2)	400	W	W
Guam: Stone	548	3,731	700	3,300	354	2,289
Virgin Islands: Stone	214	2,405	200	1,500	345	2,741

eEstimated. W Withheld to avoid disclosing company proprietary data.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Less than 1/2 unit.

Table 7.—Mineral production[1] in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1985 Quantity	1985 Value	1986 Quantity	1986 Value	1987 Quantity	1987 Value
Cement (portland)	962	$72,602	W	W	1,296	$106,185
Clays	118	264	111	$223	148	318
Lime	23	3,249	24	3,291	25	3,558
Salt	35	735	40	880	40	900
Sand and gravel (industrial)	--	--	31	624	67	W
Stone:						
Crushed	5,493	25,799	e5,400	e26,000	8,480	41,299
Dimension	W	W	--	--	--	--
Total[2]	XX	102,649	XX	r31,018	XX	152,260

eEstimated. rRevised. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Total does not include value of items not available or withheld.

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Table 8.—U.S. exports of principal minerals and products, excluding mineral fuels

Mineral	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude — metric tons	209,794	$282,958	281,163	$415,003
Scrap — do	350,858	333,187	368,492	409,686
Plates, sheets, bars, etc — do	180,057	442,681	251,572	647,890
Castings and forgings — do	6,902	59,979	6,902	65,504
Aluminum sulfate — do	2,749	1,180	1,857	1,535
Other aluminum compounds — do	29,486	28,847	46,419	40,587
Antimony, metals and alloys, crude — short tons	595	1,210	876	2,817
Bauxite including bauxite concentrate — thousand metric tons	69	12,946	201	15,232
Beryllium — pounds	79,556	7,394	170,408	5,013
Bismuth, metals and alloys — do	92,906	415	83,685	641
Cadmium metal — metric tons	38	188	241	660
Chromium:				
Ore and concentrate:				
Exports — thousand short tons	92	4,143	1	707
Reexports — do	1	511	5	352
Ferrochromium — do	6	5,693	5	5,730
Cobalt (content) — thousand pounds	631	4,726	806	7,007
Copper:				
Ore, concentrate, composition metal, unrefined (copper content) — metric tons	194,137	215,931	149,082	195,785
Scrap — do	136,422	123,138	108,535	104,920
Refined copper and semimanufactures — do	86,645	427,359	114,721	427,843
Other copper manufactures — do	9,583	20,799	3,723	9,511
Ferroalloys not elsewhere listed:				
Ferrophosphorous — short tons	38,377	4,393	34,699	4,334
Ferroalloys, n.e.c — do	10,029	11,561	19,073	14,938
Gold:				
Ore and base bullion — troy ounces	1,440,680	512,065	1,557,794	674,658
Bullion, refined — do	r3,554,411	r1,306,958	2,288,404	1,304,186
Iron ore — thousand long tons	4,482	204,738	5,013	198,254
Iron and steel:				
Pig iron — short tons	r47,051	r5,271	50,072	4,897
Iron and steel products (major):				
Steel mill products — do	r926,521	r858,386	1,093,982	949,597
Other steel products — do	r168,444	r444,053	225,587	482,464
Iron and steel scrap: Ferrous scrap including rerolling materials, ships, boats, other vessels for scrapping — thousand short tons	11,994	1,081,626	10,670	996,145
Lead:				
Ore and concentrates — metric tons	4,380	1,491	8,764	3,333
Pigs, bars, cathodes, sheets, etc — do	12,601	13,997	10,116	11,945
Scrap — do	58,998	14,921	52,823	15,670
Magnesium, metal and alloys, scrap, semimanufactured forms, n.e.c. — short tons	43,992	122,378	48,677	130,672
Manganese:				
Ore and concentrates — do	41,966	3,278	63,270	4,225
Ferromanganese — do	4,323	2,650	2,851	2,144
Silicomanganese — do	2,004	687	697	498
Metal — do	5,146	7,892	5,775	9,748
Molybdenum:				
Ore and concentrate (molybdenum content) — thousand pounds	49,153	136,006	40,514	98,381
Metal and alloys, crude and scrap — do	1,000	3,111	513	3,504
Wire — do	494	7,671	573	9,043
Semimanufactured forms, n.e.c — do	486	9,119	282	8,167
Powder — do	854	2,821	2,145	8,866
Ferromolybdenum — do	332	929	161	605
Compounds — do	17,063	24,997	2,696	11,146
Nickel:[1]				
Primary (unwrought commercially pure, cathodes, annodes, ferronickel, powder and flakes) — short tons	3,083	19,416	2,507	19,165
Wrought (bars, rods, angles, shapes, sections; plates, sheets, strip; tubes, pipes, blanks, fittings, hollow bar, wire) — do	7,443	69,836	9,887	87,595
Compound catalysts and waste and scrap — do	12,743	25,643	15,525	34,213
Platinum-group metals:				
Ore and scrap — troy ounces	368,748	103,332	276,727	84,578
Palladium, rhodium, iridium, osmiridium, ruthenium, osmium (metal and alloys including scrap) — do	277,772	56,753	341,362	93,626
Platinum (metal and alloys) — do	104,155	41,722	90,208	46,765
Rare-earth metals: Ferrocerium and alloys — metric tons	29	319	82	653
Selenium — kilograms	161,007	1,452	162,217	1,686
Silicon:				
Ferrosilicon — short tons	11,331	8,306	15,049	11,647
Silicon carbide, crude and grains (including reexports) — do	4,254	7,197	5,254	7,825

See footnotes at end of table.

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Table 8.—U.S. exports of principal minerals and products, excluding mineral fuels —Continued

Mineral		1986		1987	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS —Continued					
Silver:					
Ore, concentrates, waste, sweepings	thousand troy ounces	15,002	$85,795	15,853	$113,182
Bullion, refined	do.	10,109	56,785	11,240	79,123
Tantalum:					
Ore, metal, other forms	thousand pounds	463	15,792	416	18,665
Powder	do.	160	14,172	193	16,129
Tin:					
Ingots, pigs, bars, etc.: Exports	metric tons	1,547	9,742	1,318	9,456
Tinplate and terneplate	do.	219,074	91,793	209,526	106,156
Titanium:					
Ore and concentrate	short tons	5,314	1,414	4,435	1,395
Unwrought and scrap metal	do.	6,679	12,870	5,922	12,721
Intermediate mill shapes and mill products, n.e.c	do.	3,251	70,167	4,704	84,737
Pigments and oxides	do.	115,447	156,335	133,057	210,185
Tungsten (tungsten content):					
Ore and concentrate	metric tons	34	242	2	31
Carbide powder	do.	349	9,268	383	9,063
Alloy powder	do.	951	19,779	669	13,319
Vanadium:					
Ore and concentrate (vanadium content)	thousand pounds	177	772	--	--
Pentoxide, etc	do.	3,088	6,810	2,922	5,566
Ferrovanadium	do.	1,025	4,647	872	4,081
Zinc:					
Slabs, pigs, or blocks	metric tons	1,938	3,533	1,082	2,114
Sheets, plates, strips, other forms, n.e.c	do.	721	1,513	1,732	2,337
Waste, scrap, dust (zinc content)	do.	70,211	34,907	90,204	49,482
Semifabricated forms, n.e.c	do.	r3,141	3,356	7,096	12,534
Ore and concentrates	do.	3,269	1,590	16,921	8,304
Zirconium:					
Ore and concentrate	do.	15,852	4,567	20,054	6,802
Oxide	do.	1,647	4,010	1,206	3,948
Metals, alloys, other forms	do.	1,079	63,134	1,225	62,892
INDUSTRIAL MINERALS					
Abrasives (includes reexports):					
Industrial diamond, natural or synthetic:					
Powder or dust	thousand carats	51,163	89,812	56,792	92,858
Other	do.	3,564	30,313	2,542	27,592
Diamond grinding wheels	do.	464	5,597	493	5,964
Other natural and artificial metallic abrasives and products		XX	r 2101,207	XX	2124,984
Asbestos:					
Exports:					
Unmanufactured	metric tons	46,897	14,401	59,136	15,818
Products		XX	162,851	XX	178,953
Reexports:					
Unmanufactured	metric tons	384	119	948	331
Products		XX	1,045	XX	1,649
Barite: Natural barium sulfate	short tons	6,969	1,021	9,083	716
Boron:					
Boric acid	do.	42,178	23,562	66,614	34,180
Sodium borates, refined	do.	624,057	161,000	608,893	243,600
Bromine compounds	thousand pounds	28,000	23,900	48,300	18,000
Calcium:					
Other calcium compounds including precipitated calcium carbonate	short tons	26,833	15,000	49,978	40,705
Chloride	do.	18,168	3,962	34,718	6,657
Dicalcium phosphate	do.	51,113	42,000	83,362	53,456
Cement: Hydraulic and clinker	do.	58,556	9,024	52,009	9,563
Clays:					
Kaolin or china clay	thousand short tons	1,583	213,373	2,026	340,475
Bentonite	do.	581	44,607	539	40,596
Other	do.	749	93,182	761	131,897
Diatomite	do.	131	32,180	139	33,075
Feldspar, leucite, nepheline syenite	short tons	12,000	1,024	9,634	691
Fluorspar	do.	16,215	1,801	2,860	340,315
Gem stones (including reexports):					
Diamond	thousand carats	2,527	787,700	2,530	968,100
Pearls		XX	2,600	XX	1,860
Other		XX	111,700	XX	140,300
Graphite, natural	short tons	7,754	3,416	12,897	6,218
Gypsum:					
Crude, crushed or calcined	thousand short tons	155	15,481	127	15,629
Manufactured, wallboard and plaster articles		XX	13,324	XX	16,432
Helium	million cubic feet	432	16,200	494	18,278

See footnotes at end of table.

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Table 8.—U.S. exports of principal minerals and products, excluding mineral fuels —Continued

Mineral		1986		1987	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS —Continued					
Lime	short tons	16,448	$4,500	12,644	$2,971
Lithium compounds:					
Lithium carbonate	thousand pounds	11,579	15,978	12,750	16,751
Lithium hydroxide	do	6,388	11,141	6,930	11,033
Other lithium compounds	do	3,092	8,060	2,688	7,062
Magnesium compounds:					
Magnesite, dead-burned	short tons	23,746	5,488	14,131	3,240
Magnesite, crude, caustic-calcined, lump or ground	do	22,801	13,295	22,396	14,167
Mica:					
Waste, scrap, ground	thousand pounds	14,892	2,230	11,154	1,534
Block, film, splittings	do	98	196	170	145
Manufactured, cut or stamped, built-up	do	NA	4,502	NA	4,748
Mineral-earth pigments, iron oxide, natural and synthetic	short tons	28,841	30,830	22,249	31,689
Nitrogen compounds (major)	thousand short tons	7,754	NA	10,901	NA
Phosphate rock	thousand metric tons	7,848	211,701	8,454	194,691
Phosphatic fertilizers:					
Phosphoric acid	do	700	110,010	500	85,912
Superphosphates	do	r1,233	r155,774	1,160	192,308
Diammonium phosphates	do	4,120	641,385	5,647	890,801
Elemental phosphorus	metric tons	20,266	33,310	20,302	30,796
Pigments and compounds: Zinc oxide (metal content)	do	791	1,124	265	531
Potash:					
Potassium chloride	do	708,357	NA	511,590	NA
Potassium sulfate	do	155,608	NA	230,899	NA
Quartz, crystal:					
Cultured	thousand pounds	324	5,686	448	6,954
Natural	do	74	411	139	708
Salt:					
Crude and refined	thousand short tons	1,165	16,928	541	8,217
Shipments to noncontiguous territories	do	24	6,725	NA	NA
Sand and gravel:					
Construction:					
Sand	do	674	5,446	593	7,610
Gravel	do	492	2,392	544	2,923
Industrial sand	do	849	20,363	758	21,253
Sodium compounds:					
Sodium carbonate	do	2,049	241,238	2,224	253,200
Sodium sulfate	do	111	10,183	122	10,554
Stone:					
Crushed	do	2,921	36,957	3,320	26,063
Dimension	do	NA	14,623	NA	20,470
Sulfur, crude	thousand metric tons	1,895	251,664	1,242	139,431
Talc, crude and ground	thousand short tons	234	16,302	318	21,040
Total		XX	11,661,097	XX	13,439,507

rRevised. NA Not available. XX Not applicable.
[1]Not comparable to prior years owing to regrouping of nickel forms.
[2]Silicon carbide (crude or in gains) has been deducted and is shown separately elsewhere in this table.

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Table 9.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels

Mineral	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
METALS				
Aluminum:				
Metal ---------- metric tons	1,348,816	$1,682,907	1,245,510	$1,852,152
Scrap ---------- do	162,317	141,702	188,612	202,292
Plates, sheets, bars, etc ---------- do	455,531	914,305	415,211	840,409
Aluminum oxide (alumina) thousand metric tons	3,603	574,210	4,068	581,864
Antimony:				
Ore and concentrate (antimony content) short tons	5,855	5,892	5,634	5,732
Sulfide including needle or liquated ---------- do	576	596	102	112
Metal ---------- do	7,940	15,242	9,701	18,171
Oxide ---------- do	13,521	21,529	13,645	20,024
Arsenic:				
White (As_2O_3 content) ---------- metric tons	25,728	16,347	26,843	16,800
Metallic ---------- do	395	2,649	631	3,471
Bauxite, crude ---------- thousand metric tons	6,456	NA	9,156	NA
Beryllium ore ---------- short tons	1,510	1,324	2,302	1,944
Bismuth, metals and alloys (gross weight) ---------- pounds	2,489,634	6,895	3,484,713	8,769
Cadmium metal ---------- metric tons	3,174	6,208	2,701	7,818
Calcium metal ---------- pounds	566,170	1,310	776,225	1,918
Cesium compounds and chloride ---------- do	37,487	1,161	73,892	4,033
Chromium:				
Ore and concentrate (Cr_2O_3 content) thousand short tons	214	21,657	229	23,774
Ferrochromium (gross weight) ---------- do	388	172,694	326	150,269
Ferrochromium-silicon ---------- do	9	5,743	8	4,920
Metal ---------- do	4	21,647	4	24,096
Cobalt:				
Metal ---------- thousand pounds	11,669	83,295	18,612	122,791
Oxide (gross weight) ---------- do	511	4,202	795	5,293
Salts and compounds (gross weight) ---------- do	805	2,669	903	2,004
Columbium ore ---------- do	2,854	4,541	4,581	6,612
Copper (copper content):				
Ore and concentrate ---------- metric tons	4,232	2,593	2,339	2,013
Matte ---------- do	702	573	6,869	9,339
Blister ---------- do	34,545	60,236	24,084	41,976
Refined in ingots, etc ---------- do	501,984	677,010	469,181	734,725
Scrap ---------- do	27,216	31,646	33,123	45,122
Ferroalloys not elsewhere listed, including spiegeleisen short tons	3,896	18,588	3,940	22,722
Gallium ---------- kilograms	17,202	6,954	12,490	4,874
Germanium ---------- do	12,911	7,526	17,498	10,491
Gold:				
Ore and base bullion ---------- troy ounces	1,948,996	677,337	1,420,200	580,025
Bullion, refined ---------- do	13,800,451	5,016,558	2,423,053	1,052,941
Hafnium ---------- short tons	(1)	76	1	180
Indium ---------- thousand troy ounces	1,380	4,633	1,522	9,796
Iron ore (usable) ---------- thousand long tons	16,743	460,643	16,583	408,783
Iron and steel:				
Pig iron ---------- short tons	294,967	42,482	354,712	52,500
Iron and steel products (major):				
Steel mill products ---------- do	r20,676,642	r8,019,473	20,350,816	8,567,164
Other products ---------- do	r1,257,473	r1,308,091	1,020,073	1,143,999
Scrap including tinplate --- thousand short tons	724	49,073	843	82,016
Lead:				
Ore, flue dust, matte (lead content) --- metric tons	4,604	1,344	873	308
Base bullion (lead content) ---------- do	142	114	10,827	7,239
Pigs and bars (lead content) ---------- do	140,221	59,172	185,673	123,157
Reclaimed scrap, etc. (lead content) ---------- do	3,290	1,471	6,587	3,128
Sheets, pipes, shot ---------- do	1,344	1,825	2,793	5,301
Magnesium:				
Metal and scrap ---------- short tons	r5,192	r12,010	6,832	16,223
Alloys (magnesium content) ---------- do	1,808	7,008	2,921	8,624
Sheets, tubing, ribbons, wire, other forms (magnesium content) ---------- do	2,210	5,556	2,208	6,117
Manganese:				
Ore (35% or more contained manganese) --- do	463,242	23,122	340,539	15,079
Ferromanganese ---------- do	395,650	120,482	367,675	113,630
Ferrosilicon-manganese (manganese content) do	131,425	58,839	124,315	58,461
Metal ---------- do	9,668	9,800	8,925	9,600
Mercury:				
Compounds ---------- pounds	316,224	1,395	475,015	2,136
Metal ---------- 76-pound flasks	20,187	4,176	18,451	3,860

See footnotes at end of table.

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Table 9.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
METALS —Continued				
Molybdenum:				
Ore and concentrate (molybdenum content) thousand pounds	1,120	$3,057	1,264	$3,109
Waste and scrap (gross weight) do	NA	2,870	NA	2,545
Metal:				
Unwrought (molybdenum content) do	191	2,510	174	2,308
Wrought (gross weight) do	102	2,701	158	2,801
Ferromolybdenum (gross weight) do	1,599	3,626	3,815	8,042
Material in chief value molybdenum (molybdenum content) do	1,102	3,284	5,248	15,497
Compounds (gross weight) do	4,650	9,091	6,711	13,407
Nickel:				
Pigs, ingots, shot, cathodes short tons	99,017	407,210	113,249	455,126
Plates, bars, etc do	6,590	53,894	5,444	54,861
Slurry do	9,170	19,281	5,241	24,754
Scrap do	6,795	19,581	7,567	25,133
Powder and flakes do	10,342	51,051	11,977	60,406
Ferronickel do	37,901	53,672	45,389	57,481
Oxide do	2,868	4,372	2,278	4,277
Platinum-group metals:				
Unwrought:				
Grains and nuggets (platinum) troy ounces	10,465	4,758	821	368
Sponge (platinum) do	1,713,971	780,382	1,124,018	621,321
Sweepings, waste, scrap do	737,813	95,466	624,916	106,920
Iridium do	30,368	13,517	11,814	4,319
Palladium do	1,387,131	174,856	1,529,161	210,670
Rhodium do	179,068	195,666	211,466	249,811
Ruthenium do	176,580	13,649	84,399	6,269
Other platinum-group metals do	32,010	9,217	17,620	6,204
Semimanufactured:				
Platinum do	94,655	44,766	45,804	24,840
Palladium do	114,596	14,376	151,499	22,312
Rhodium do	1	3	829	649
Other platinum-group metals do	519	59	4,200	925
Rare-earth metals:				
Ferrocerium and other cerium alloys kilograms	r94,370	r1,151	94,829	1,294
Monazite metric tons	2,960	1,106	1,121	627
Metals including scandium and yttrium kilograms	19,558	1,837	13,490	1,350
Rhenium:				
Metal including scrap pounds	5,495	2,617	7,436	2,072
Ammonium perrhenate (rhenium content) do	r12,189	r2,199	7,225	2,122
Selenium and selenium compounds (selenium content) kilograms	462,646	9,550	495,862	10,108
Silicon:				
Metal (over 96% silicon content) short tons	r40,851	65,180	36,930	74,298
Ferrosilicon do	223,031	100,578	230,658	108,749
Silver:				
Ore and base bullion thousand troy ounces	5,516	30,926	2,681	18,019
Bullion, refined do	125,365	688,296	67,959	460,235
Sweepings, waste, doré do	14,008	78,962	11,186	76,372
Tantalum ore thousand pounds	905	7,713	697	5,186
Tellurium (gross weight) kilograms	30,721	911	26,700	808
Thallium pounds	r2,902	r91	3,138	89
Tin:				
Concentrate (tin content) metric tons	3,936	13,693	2,953	9,509
Dross, skimmings, scrap, residue, tin alloys, n.s.p.f. do	1,121	1,899	2,270	9,241
Tinfoil, powder, flitters, etc	XX	1,280	XX	1,854
Tin compounds metric tons	860	5,165	838	5,162
Titanium:				
Ilmenite[2] short tons	827,489	81,563	789,585	94,987
Rutile do	174,820	52,214	218,188	72,113
Metal do	r5,194	r34,203	4,521	29,759
Ferrotitanium and ferrosilicon-titanium do	681	1,421	1,425	2,521
Pigments do	202,674	240,058	192,043	236,945
Tungsten ore and concentrate (tungsten content) metric tons	2,522	13,840	4,414	23,964
Vanadium (vanadium content):				
Ferrovanadium thousand pounds	1,189	6,423	685	3,777
Pentoxide do	824	3,564	457	2,210
Vanadium-bearing materials do	4,027	5,720	4,528	5,903

See footnotes at end of table.

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Table 9.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1986 Quantity	1986 Value (thousands)	1987 Quantity	1987 Value (thousands)
METALS —Continued				
Zinc:				
Ore and concentrates (zinc content) — metric tons	75,786	$19,096	46,464	$12,322
Blocks, pigs, slabs — do	665,126	487,030	705,985	581,221
Sheets, etc — do	3,811	3,048	960	1,384
Fume (zinc content) — do	11	2	16	18
Waste and scrap — do	4,521	1,937	4,025	1,928
Dross and skimmings — do	6,087	3,098	6,711	3,443
Dust, powder, flakes — do	7,446	8,260	7,001	7,940
Manufactured — do	XX	1,206	XX	1,570
Zirconium:				
Ore including zirconium sand — do	68,764	7,836	67,917	10,243
Metal, scrap, compounds — do	3,280	18,974	4,233	25,592
INDUSTRIAL MINERALS				
Abrasives:				
Diamond (industrial) — thousand carats	45,991	110,648	48,877	95,555
Other	XX	294,125	XX	329,105
Asbestos — metric tons	108,352	26,537	93,763	22,022
Barite:				
Crude and ground — thousand short tons	767	28,858	837	29,519
Witherite — short tons	147	78	436	144
Chemicals — do	31,603	21,733	42,537	22,072
Boron:				
Boric acid (contained boron oxide) — do	3,000	3,824	2,240	2,899
Colemanite (contained boron oxide) — thousand short tons	16,000	8,770	8	2,763
Ulexite — do	42	17,766	52	20,597
Bromine (contained in compounds) — thousand pounds	18,815	9,734	25,326	19,237
Calcium chloride:				
Crude — short tons	143,328	14,403	229,964	20,917
Other — do	2,098	1,264	1,282	706
Cement: Hydraulic and clinker — thousand short tons	16,319	468,993	17,726	488,532
Clays — short tons	38,398	7,501	37,679	9,392
Cryolite — do	11,344	6,959	13,605	7,693
Feldspar:				
Crude — do	568	474	344	4
Ground and crushed — do	683	68	4,489	472
Fluorspar — do	552,785	45,675	585,901	48,429
Gem stones:				
Diamond — thousand carats	9,192	3,459,931	9,121	3,423,094
Emeralds — do	2,757	152,396	2,075	141,575
Other	XX	566,325	XX	524,851
Graphite, natural — short tons	42,790	15,758	47,768	17,654
Gypsum:				
Crude, ground, calcined — thousand short tons	9,562	65,432	9,719	59,555
Manufactured — do	XX	115,735	XX	104,026
Iodine, crude — thousand pounds	3,028	17,199	2,542	17,595
Lime:				
Hydrated — short tons	57,842	4,108	39,734	3,021
Other — do	142,865	8,129	138,171	7,558
Lithium:				
Ore — do	13,327	3,616	18,174	3,987
Compounds — do	2,095	9,166	2,309	6,485
Magnesium compounds:				
Crude magnesite — do	37	15	3,318	733
Lump or ground caustic-calcined magnesia — do	78,742	11,493	42,011	4,575
Refractory magnesia, dead-burned, fused magnesite, dead-burned dolomite — do	213,135	38,906	223,555	43,539
Compounds — do	39,807	11,038	70,746	20,593
Mica:				
Waste, scrap, ground — thousand pounds	21,962	3,549	21,142	3,928
Block, film, splittings — do	r1,866	r653	2,460	1,230
Manufactured, cut or stamped, built-up — do	r2,105	4,859	1,645	5,125
Mineral-earth pigments, iron oxide:				
Ocher, crude and refined — short tons	604	78	59	99
Siennas, crude and refined — do	144	73	289	177
Umber, crude and refined — do	5,855	1,071	6,123	1,058
Vandyke brown — do	572	293	1,576	342
Other natural and refined — do	845	619	1,598	769
Synthetic — do	28,754	19,382	32,679	18,235
Nepheline syenite:				
Crude — do	2,970	205	3,720	142
Ground, crushed, etc — do	295,836	11,075	304,965	11,259
Nitrogen compounds (major) including urea — thousand short tons	7,903	777,906	7,065	582,553

See footnotes at end of table.

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Table 9.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS —Continued				
Peat:				
Fertilizer-grade ____ short tons	540,729	$68,054	500,142	$69,076
Poultry- and stable-grade ____ do	12,367	1,452	14,373	1,890
Phosphates, crude and apatite ____ thousand metric tons	528	22,265	464	18,816
Phosphatic fertilizers:				
Fertilizer and fertilizer materials ____ do	69	8,351	55	7,820
Elemental phosphorus ____ do	2	3,548	4	6,609
Other ____ do	2	473	53	8,514
Pigments and salts:				
Lead pigments and compounds ____ metric tons	r17,133	12,932	21,213	21,145
Zinc pigments and compounds ____ do	57,317	47,006	68,672	60,078
Potash ____ do	6,933,800	385,100	6,706,200	432,700
Pumice:				
Crude or unmanufactured ____ short tons	3,488	297	17,353	2,414
Wholly or partly manufactured ____ do	509	204	1,201	380
Manufactured, n.s.p.f ____	XX	512	XX	899
Quartz crystal (Brazilian lascas) ____ thousand pounds	52	51	146	157
Salt ____ thousand short tons	6,665	79,709	5,716	66,936
Sand and gravel:				
Industrial sand ____ do	88	1,014	104	1,071
Other sand and gravel ____ do	205	1,412	283	2,367
Sodium compounds:				
Sodium carbonate ____ do	106	15,023	150	18,334
Sodium sulfate ____ do	188	13,829	138	10,363
Stone:				
Crushed ____ do	2,864	10,902	3,595	12,500
Dimension ____	XX	379,724	XX	439,278
Calcium carbonate fines ____ thousand short tons	351	1,548	263	1,524
Strontium:				
Minerals ____ short tons	33,236	3,396	42,469	3,670
Compounds ____ do	8,495	5,871	10,004	7,307
Sulfur and compounds, sulfur ore and other forms, n.e.s ____ thousand metric tons	1,347	142,220	1,599	152,096
Talc, unmanufactured ____ thousand short tons	52	8,715	53	10,348
Total[3] ____	XX	31,964,000	XX	28,416,000

rRevised. NA Not available. XX Not applicable.
[1]Less than 1/2 unit.
[2]Includes titanium slag averaging about 70% TiO_2. For details, see "Titanium" chapter.
[3]Data may not add to totals shown because of independent rounding.

Table 10.—Comparison of world and U.S. production of selected nonfuel mineral commodities

(Thousand short tons unless otherwise specified)

Mineral	1986			1987p		
	World production[1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
METALS, MINE BASIS						
Antimony (content of ore and concentrate) short tons	64,146	W	NA	61,875	--	--
Arsenic trioxide[2] ____ metric tons	56,513	--	--	54,840	--	--
Bauxite[3] ____ thousand metric tons	86,093	510	1	90,302	576	1
Beryl ____ short tons	9,897	6,533	66	9,480	6,062	64
Bismuth ____ thousand pounds	8,711	W	NA	8,956	W	NA
Chromite ____	12,327	--	--	12,222	--	--
Cobalt (content of ore and concentrate) thousand pounds	107,812	--	--	103,246	--	--
Columbium-tantalum concentrate (gross weight) ____ do	76,666	--	--	70,442	--	--
Copper (content of ore and concentrate) thousand metric tons	8,125	1,147	14	8,475	1,256	15

See footnotes at end of table.

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Table 10.—Comparison of world and U.S. production of selected nonfuel mineral commodities —Continued

(Thousand short tons unless otherwise specified)

Mineral	1986			1987[p]		
	World production[1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
METALS, MINE BASIS —Continued						
Gold (content of ore and concentrate) thousand troy ounces	51,620	3,739	7	52,481	4,966	9
Iron ore (gross weight) thousand long tons	NA	38,862	NA	NA	46,817	NA
Lead (content of ore and concentrate) thousand metric tons	3,376	353	10	3,454	319	9
Manganese ore (gross weight)	26,158	--	--	25,101	--	--
Mercury thousand 76-pound flasks	179	W	NA	179	W	NA
Molybdenum (content of ore and concentrate) thousand pounds	203,466	93,976	46	186,405	75,117	40
Nickel (content of ore and concentrate)	836	1	(4)	867	--	--
Platinum-group metals[3] thousand troy ounces	8,314	W	NA	8,671	W	NA
Silver (content of ore and concentrate) do	415,929	34,524	8	429,091	39,790	9
Tin (content of ore and concentrate) metric tons	179,377	W	NA	179,713	W	NA
Titanium concentrates (gross weight):						
Ilmenite	3,735	W	NA	4,061	W	NA
Rutile	433	W	NA	496	W	NA
Tungsten (content of ore and concentrate) metric tons	42,656	780	2	40,232	34	(4)
Vanadium (content of ore and concentrate) short tons	32,530	W	NA	34,300	W	NA
Zinc (content of ore and concentrate) thousand metric tons	6,829	216	3	7,144	233	3
METALS, SMELTER BASIS						
Aluminum (primary only) do	15,341	3,037	20	16,016	3,343	21
Cadmium metric tons	18,525	1,486	8	18,566	1,515	8
Cobalt short tons	67,622	--	--	59,391	--	--
Copper smelter (primary and secondary)[5] thousand metric tons	8,715	1,196	14	8,865	1,249	14
Iron, pig (shipments)	553,369	44,287	8	564,918	48,308	9
Lead (primary and secondary)[6] thousand metric tons	5,541	995	18	5,647	1,084	19
Magnesium (primary)	362	138	38	355	137	39
Nickel[7]	862	2	(4)	892	--	--
Selenium[8] kilograms	1,193,744	W	NA	1,245,059	W	NA
Steel, raw	783,347	[9]81,606	10	804,164	88,472	11
Tellurium[8] kilograms	85,436	W	NA	90,305	W	NA
Tin metric tons	191,403	[10]3,213	2	189,556	[10]3,927	2
Zinc (primary and secondary) thousand metric tons	6,761	316	5	7,030	343	5
INDUSTRIAL MINERALS						
Asbestos do	4,050	51	1	4,054	51	1
Barite	5,204	[11]297	6	5,137	[11]448	9
Boron minerals	2,687	1,251	47	2,898	1,385	48
Bromine thousand pounds	824,380	[11]310,000	38	846,530	[11]335,000	40
Cement, hydraulic	1,100,814	[12]79,916	7	1,138,673	[12]79,501	7
Clays:						
Bentonite[2]	9,703	[11]2,813	29	9,579	2,806	29
Fuller's earth[2]	2,438	[11]1,910	78	2,642	[11]2,057	78
Kaolin[2]	26,152	[11]8,549	33	26,491	[11]8,827	33
Diamond thousand carats	91,756	--	--	93,029	--	--
Diatomite	2,042	628	31	2,008	658	33
Feldspar	4,610	735	16	4,531	720	16
Fluorspar	5,232	78	1	5,244	80	2
Graphite short tons	736,513	--	--	694,167	--	--
Gypsum	95,360	15,403	16	98,897	15,612	16
Iodine, crude thousand pounds	28,484	W	NA	27,913	W	NA
Lime	120,964	[11 12]14,498	12	122,715	[11 12]15,758	13
Magnesite	16,313	W	NA	16,454	W	NA
Mica (including scrap and ground) thousand pounds	636,207	296,300	47	654,531	321,100	49
Nitrogen: N content of ammonia	99,275	11,499	12	102,653	13,284	13
Peat	236,505	912	(4)	252,465	955	(4)

See footnotes at end of table.

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Table 10.—Comparison of world and U.S. production of selected nonfuel mineral commodities —Continued

(Thousand short tons unless otherwise specified)

Mineral	1986			1987[p]		
	World production[1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
INDUSTRIAL MINERALS —Continued						
Perlite	1,804	[11]507	28	1,829	[11]533	29
Phosphate rock (gross weight) thousand metric tons	138,740	38,710	28	145,148	40,954	28
Potash (K_2O equivalent) do	28,758	1,202	4	29,812	1,202	4
Pumice[6]	11,458	[11]554	5	11,753	[11]392	3
Salt	194,720	[11 12]36,703	19	195,594	[11 12]36,532	19
Sodium compounds, natural and manufactured:						
Carbonate	31,179	8,438	27	32,395	8,891	27
Sulfate	4,974	812	16	5,007	805	16
Strontium[8] short tons	164,809	--	--	202,342	--	--
Sulfur, all forms thousand metric tons	54,074	11,087	21	54,221	10,538	19
Talc and pyrophyllite	8,256	1,302	16	8,310	1,349	16
Vermiculite[9]	579	[11]317	55	601	[11]303	50

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]The reporting of world production of natural corundum was dropped from the 1987 edition of the Minerals Yearbook, therefore, corundum no longer appears in this table. For those commodities for which U.S. data are withheld to avoid disclosing company proprietary data, the world total excludes U.S. output and the U.S. percentage of world production cannot be reported.

[2]World total does not include an estimate for output in China.

[3]U.S. figures represent dried bauxite equivalent of crude ore; to the extent possible, individual country figures that are included in the world total are also on the dried bauxite equivalent basis, but for some countries, available data are insufficient to permit this adjustment.

[4]Less than 0.5%.

[5]Primary and secondary blister and anode copper, including electrowon refined copper that is not included as blister or anode.

[6]Includes bullion.

[7]Refined nickel plus nickel content of ferronickel and nickel oxide.

[8]World total does not include estimates for output in the U.S.S.R. or China.

[9]Data from American Iron and Steel Institute. Excludes production of castings by companies that do not report steel ingot.

[10]Includes tin content of alloys made directly from ore.

[11]Quantity sold or used by producers.

[12]Includes Puerto Rico.

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The Mineral Industry of Alabama

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Alabama for collecting information on all nonfuel minerals.

By James R. Boyle[1] and Ernest A. Mancini[2]

The value of Alabama's nonfuel mineral production in 1987 was $446.6 million, an increase over that of 1986 and the first increase in 3 years. Alabama was second in the Nation in production of bauxite and ferroalloys; third in bentonite, crushed dolomite, crushed marble, and fire clay; and fourth in masonry cement.

Trends and Developments.—Employment in the minerals industry remained relatively low for the second year even though the overall unemployment rate dropped to 7.9% by December. Employment in mining and primary metals dropped about 10% and 2%, respectively.

Table 1.—Nonfuel mineral production in Alabama[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ____ thousand short tons	268	$18,113	267	$18,165	291	$17,626
Portland ____ do.	3,721	165,972	3,477	153,629	3,600	160,878
Clays[2] ____ do.	1,873	13,139	2,077	14,828	2,239	16,217
Gem stones	NA	e1	NA	1	NA	7
Lime ____ thousand short tons	1,216	52,295	1,180	50,377	1,232	52,200
Sand and gravel:						
Construction ____ do.	e11,000	e32,000	10,781	30,807	e10,300	e35,600
Industrial ____ do.	524	4,533	433	3,388	580	5,025
Stone:						
Crushed ____ do.	25,853	109,176	e24,000	e120,500	30,018	146,247
Dimension ____ do.	10	2,661	e8	e968	W	W
Combined value of bauxite, clays (bentonite), salt, and value indicated by symbol W	XX	8,719	XX	12,553	XX	12,843
Total	XX	406,609	XX	405,216	XX	446,643

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Alabama in 1986, by county[1]

County	Minerals produced in order of value
Autauga	Sand and gravel (construction).
Baldwin	Clays.
Barbour	Clays, bauxite, sand and gravel (construction).
Bibb	Clays.
Blount	Cement, sand and gravel (construction).
Calhoun	Clays, sand and gravel (construction).
Chilton	Sand and gravel (construction), clays.
Clarke	Sand and gravel (construction).
Coffee	Do.
Conecuh	Do.
Dale	Do.
Dallas	Sand and gravel (construction), clays.
Elmore	Do.
Escambia	Sand and gravel (construction).
Etowah	Do.
Franklin	Do.
Geneva	Do.
Hale	Do.
Henry	Bauxite.
Jefferson	Cement, clays.
Lowndes	Clays, sand and gravel (construction).
Macon	Sand and gravel (construction), sand and gravel (industrial).
Madison	Sand and gravel (construction), clays.
Marengo	Cement.
Marion	Sand and gravel (construction).
Marshall	Clays.
Mobile	Cement, sand and gravel (construction), sand and gravel (industrial).
Montgomery	Sand and gravel (construction), sand and gravel (industrial), clays.
Russell	Clays, sand and gravel (construction).
St. Clair	Cement, clays.
Shelby	Lime, cement, clays.
Sumter	Clays, sand and gravel (construction).
Tuscaloosa	Sand and gravel (construction), sand and gravel (industrial).
Walker	Clays.
Washington	Salt, sand and gravel (construction).
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

The Tennessee-Tombigbee Waterway handled over 4 million short tons of cargo in 1987, mainly mineral commodities. Crushed stone was the top cargo with over 800,000 tons. Stone was being shipped from North Alabama and from out of State to storage yards along the waterway and to various coastal markets.

The Port of Mobile handled 29.4 million short tons of cargo in 1987 compared with 38.7 million tons in 1986. Mineral commodities handled at the Alabama State Docks included exports of coal (7.1 million tons) and imports of iron ore (1.1 million tons), ilmenite and rutile (165,000 tons), potash (100,000 tons), gypsum (85,000 tons), and manganese (35,000 tons). Construction commodities imported through industry docks included sand and gravel (650,000 tons), shell (380,000 tons), and crushed stone (130,000 tons). Other general port tonnage imported included coal (4.0 million tons) and cement clinker (600,000 tons).

The first phase of the Mobile Ship Channel deepening to 45 feet began at midyear. This phase of the project will deepen the channel from the McDuffie Coal Terminal to the gulf, slightly more than 30 miles.

The Department of Industrial Relations reported that coal production for fiscal year 1987 decreased to 24.6 million short tons. Of the coal operations, 15 were underground and 101 were surface mines; nearly 14 million tons was produced from underground mines. Each of seven mines produced in excess of 1 million tons; all were underground.

The Alabama Development Office (ADO) announced that capital investments in new and expanding industries increased from $1.3 billion in 1986 to $2.4 billion in 1987. In the mineral-related sector, mining and quarrying of industrial minerals had 1 new operation and 8 expansions totaling $5.7 million; stone, clay, glass, and concrete products had 3 new operations and 37 expansions totaling $34.4 million; and primary metals had 3 new operations and 46 expansions totaling $224.9 million. ADO also reported four companies utilized industrial revenue bonds totaling $13.4 million for expansion of their operations.

Legislation and Government Programs.—The Secretary of the Interior approved a grant of $123,000 in Federal coal mine reclamation funds for the State of

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Alabama to be used to reclaim six iron ore mines in the Birmingham area. The Office of Surface Mining will assist the State Department of Industrial Relations in closing and reclaiming these abandoned mines.

The State Lands Division of the Department of Conservation and Natural Resources manages State lands not being used for specific purposes. In fiscal year 1987, royalty receipts totaled $2.7 million, down from $3.0 million in fiscal year 1986. The sources of the receipts were $1.7 million from oil and gas, $682,000 from coal, and $197,000 from sand and gravel. The balance was from permits, various fees, and easements.

The Bureau of Mines Tuscaloosa Research Center conducted research on improved ceramic materials, dewatering of waste streams, fine grinding of various minerals, and other beneficiation studies. In addition, the Bureau conducted research on mining safety and health directly related to the State's coal industry.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Industrial minerals accounted for the bulk of the value of Alabama's total nonfuel mineral production. Although operating at reduced levels, the industry optimistically continued expansion and development.

Cement.—Masonry and portland cements accounted for about 40% of the value of nonfuel minerals produced in Alabama. Alabama ranked fourth nationally in the production of masonry cement and sixth in portland cement. Output of both types of cement increased slightly over that of 1986.

Portland cement was produced at six plants: two in Jefferson County and one each in Marengo, Mobile, St. Clair, and Shelby Counties. Five plants used the dry process while one used the wet process; eight kilns were available. Seven plants produced masonry cement, with Cheney Lime & Cement Co. being one of two plants nationally that produced only masonry cement. Of the six operating companies, five were owned by foreign interests. Expansion and modernization projects at cement plants announced by ADO totaled in excess of $10 million. Improvements were also made by Blue Circle and Citadel Cement Corp.

Ideal Basic Industries Inc. announced plans to reopen its Mobile plant by late 1988 basically because the fall in the value of the dollar made its products more competitive. The 1.5-million-short-ton-per-year plant has been idle since 1984. Ideal will spend $3.1 million to modify the raw-material-processing and fuel-firing sections of the plant. For the first year, production will be geared at two-thirds of capacity. Ideal's Dominican Republic quarry will furnish stone until a source of domestic stone from West Florida can be developed.

Clays.—Common clay, fire clay, bentonite, and kaolin were produced in Alabama with total output and value increasing over that of 1986. Clays ranked fifth in mineral value in the State in 1987 as 21 companies mined clay at 31 pits in 18 counties. Alabama ranked third in the Nation in output of bentonite and fire clay and sixth in kaolin.

ADO reported three expansions in the clay industry, two in brick plants and one in a ceramic tile plant. Total expenditure was $275,000.

Common clay was mined by 18 companies at 18 pits in 14 counties. Leading counties were Jefferson, Shelby, and Sumter. Output increased; major uses were brick, cement, and concrete block.

CRH PLC, a company based in Dublin, Ireland, acquired Big River Industries Inc. for $22 million. Livlite Corp., a division of Big River, operates a 1.2-million-cubic-yard lightweight aggregate facility at Livingston. CRH plans to increase capacity of the Livlite plant by 50%. Livlite applied for a permit to use waste-derived fuels for its kilns, supplementing the coal now used.

Fire clay output and value increased over that of 1986. Fire clay was mined by four companies at five pits in Calhoun, St. Clair, and Shelby Counties.

Bentonite was mined by American Colloid Co. at its facilities in Lowndes County for use in drilling mud and the foundry industry; output and value increased.

Kaolin was mined by three companies at seven pits in Barbour and Henry Counties. Production and value increased. Major uses were in firebrick and other refractories. Kaolin occurred in association with bauxite, which was also used for refractory purposes. Mining companies continued to operate at reduced levels during 1987.

Lime.—Alabama ranked fifth in the Nation in production of lime, which was the third most valuable commodity produced in the State in 1987. Four companies produced lime in five plants in Shelby County. Output of hydrated lime and quicklime increased.

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Table 3.—Alabama: Lime sold or used by producers, by use

Use	1986		1987	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Paper and pulp	353,523	$14,865	365,256	$15,232
Water purification	193,744	8,395	212,251	8,959
Sewage treatment	W	W	64,986	2,950
Road and soil stabilization	25,296	1,107	W	W
Other[1]	607,678	26,010	589,255	25,059
Total	1,180,241	50,377	1,231,748	52,200

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes acid water neutralization, agriculture, alkalies, aluminum and bauxite, animal and human food, basic oxygen steel, electric steel, finishing lime, magnesia from seawater or brine (1986), mason's lime, oil well drilling (1986), open-hearth steel ore concentration, other chemical and industrial, other construction, other metallurgy, paint, petroleum refining, soil stabilization, sugar refining, wire drawing, and data indicated by symbol W.

Salt.—Alabama ranked eighth nationally in output of salt. Olin Corp. produced salt from brine wells by solution mining a near-surface salt dome in Washington County. Production increased but unit values decreased from those of 1986. Alabama Electric Cooperative announced plans to spend $14.9 million to develop the Nation's first compressed-air energy storage plant at a large salt dome. The facility will have a 26-hour running capacity and was scheduled for operation by 1989. The 40-acre site is owned by Olin, who will use the brine from the dome in its manufacturing process.

Sand and Gravel.—Alabama produced both construction and industrial sand and gravel in 1987. Total sand and gravel production was estimated to have decreased while value increased, indicating an increase in unit values.

Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel ranked fourth in terms of mineral value in Alabama in 1987 with output decreasing; unit values increased. Most operations were relatively small with no individual pit producing over 1 million short tons. ADO reported two expansions in the industry totaling $1.2 million. Companies involved in expansion were Donnell Sand Co., Daleville, and Southern Silica Inc., Elmore. Friese Materials Corp., a sand and gravel producer, installed a washing and dewatering bucket wheel at its Atmore plant.

Industrial.—Seven companies produced industrial sand and gravel with output increasing. Industrial sand and gravel was used primarily by foundries for molds and cores. All operations were relatively small with individual output under 200,000 short tons per year. U.S. Silica Co., Berkeley Springs, WV, purchased Warrior Sand Co. of Hurtsboro. Warrior produces a high purity silica sand for use in the foundry industry.

Slag—Iron and Steel.—Jim Walter Resources Inc., Birmingham, and Vulcan Materials Co., Fairfield and Gadsden, air-cooled slag from blast furnaces, which was used as road base, railroad ballast, and asphaltic concrete aggregate. Vulcan sold steel slag for similar uses. Output of both remained the same as that in 1986.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone ranked second in mineral value in Alabama with output increasing over that of 1986. Mined material included dolomite, granite, limestone, and marble. Alabama was third in the Nation in production of crushed dolomite and crushed marble. Crushed stone was produced by 28 companies at 47 operations in 20 counties. Principal production was from Shelby, Jefferson, and Madison Counties. Crushed stone was used primarily in cement manufacture, as concrete aggregate, and as a road base. Eleven companies produced in excess of 1 million short tons per year and accounted for 81% of all crushed stone. Transportation was mainly by truck.

E.C.C. America Inc. acquired Moretti-Harrah Marble Co.'s Sylacauga Calcium Products Div. for $25 million. The facility has a capacity of 200,000 short tons per year of calcium carbonate that was used by paint and polymer manufacturers. Southern Ready-Mix Inc., Birmingham, announced a $7.5 million expansion. Plans include reactivating a stone quarry in Tarrant and construction of a new concrete pipe plant. Vulcan Materials Co., Birmingham, and Mexico's Grupo ICA formed a joint venture to supply construction aggre-

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gates to gulf coast markets. A large quarry in the Yucatán Peninsula of Mexico, capable of producing 6 million short tons per year, will ship the material to major ports along the gulf. Hoover Inc. opened its new 1.2-million-short-ton-per-year quarry in Huntsville early in the year.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 5 presents end-use data for crushed stone produced in the three Alabama districts depicted in figure 1.

Table 4.—Alabama: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Concrete aggregate (+1-1/2 inch): Riprap and jetty stone	829	3,351
Coarse aggregate, graded:		
Concrete aggregate, coarse	4,244	18,261
Bituminous aggregate, coarse	1,747	7,145
Bituminous surface-treatment aggregate	1,814	5,397
Fine aggregate (-3/8 inch):		
Stone sand, concrete	860	3,369
Stone sand, bituminous mix or seal	1,067	4,311
Screening, undesignated	282	892
Coarse and fine aggregates:		
Graded road base or subbase	2,623	9,832
Unpaved road surfacing	274	975
Terrazzo and exposed aggregate	533	2,416
Crusher run or fill or waste	3,145	12,291
Other construction materials[2]	531	2,092
Agricultural: Agricultural limestone	728	4,615
Chemical and metallurgical:		
Cement manufacture	3,795	11,088
Lime manufacture	1,535	5,742
Flux stone	167	827
Special:		
Other fillers and extenders	555	16,773
Other miscellaneous[3]	290	5,508
Other unspecified[4]	4,999	31,362
Total	30,018	146,247

[1]Includes limestone, dolomite, granite and marble.
[2]Includes filter stone and railroad ballast.
[3]Includes poultry grit and mineral food, other agricultural uses, asphalt fillers or extenders, mine dusting and acid water treatment, and whiting or whiting substitute.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

Table 5.—Alabama: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	392	1,106	440	2,257	--	--
Coarse aggregate, graded[2]	W	W	4,824	18,577	(3)	(3)
Fine aggregate (-3/8 inch)[4]	W	W	W	W	--	--
Coarse and fine aggregates[5]	3,239	12,260	3,337	13,254	--	--
Other construction	3,240	12,734	1,645	6,395	--	--
Agricultural[6]	(3)	(3)	322	1,967	(3)	(3)
Chemical and metallurgical[7]	--	--	5,497	17,657	--	--
Special[8]	--	--	784	21,913	--	--
Other unspecified[9]	802	3,572	1,971	15,489	3,525	19,066
Total	7,673	29,672	18,820	[10]97,508	3,525	19,066

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes riprap and jetty stone and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[4]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[5]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[6]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[7]Includes cement manufacture, lime manufacture, and flux stone.
[8]Includes mine dusting, asphalt filler, whiting or whiting substitute, and other fillers or extenders.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data do not add to total shown because of independent rounding.

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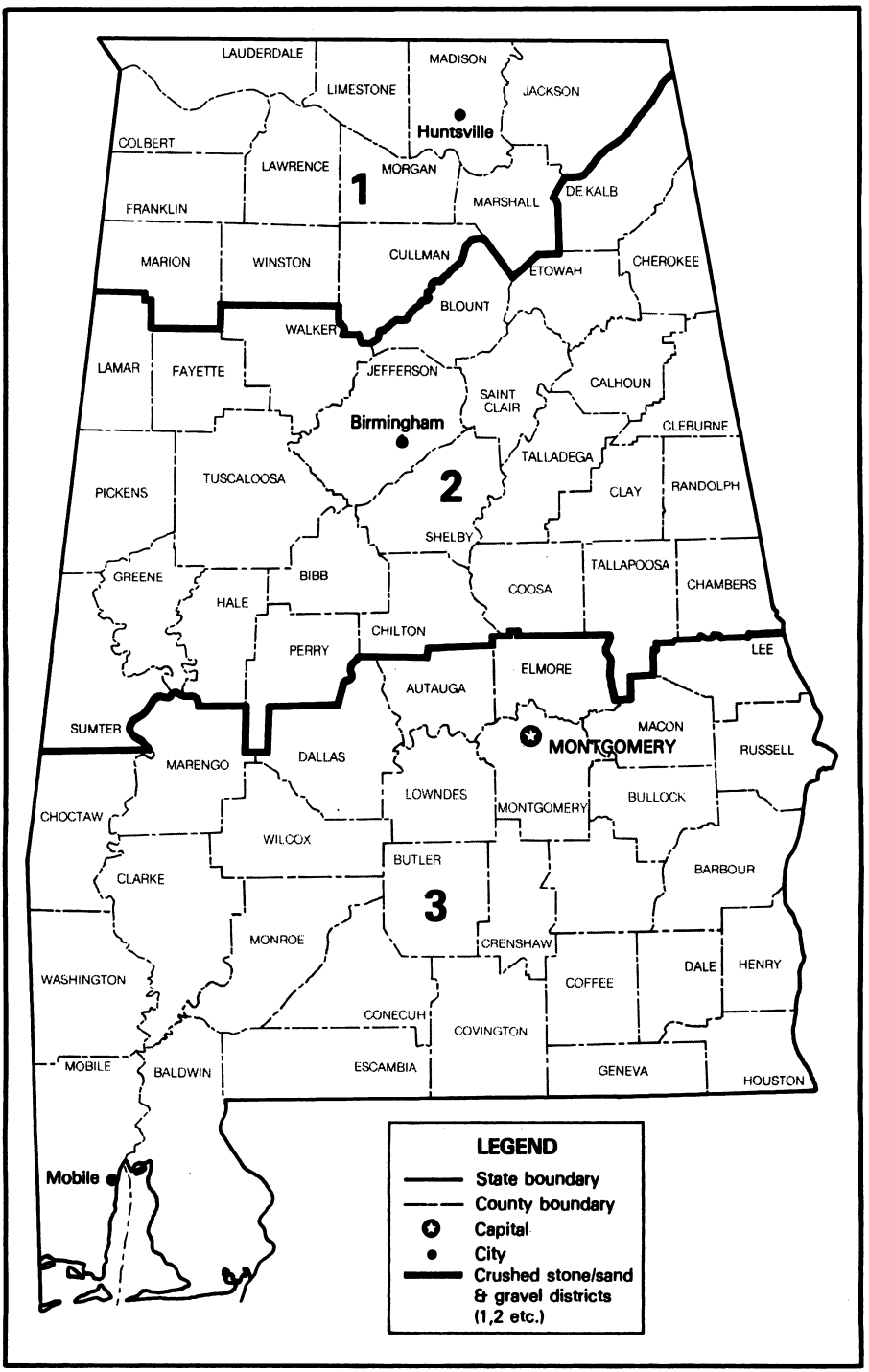

Figure 1.—Aggregate-producing districts in Alabama.

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Dimension.—Output of dimension stone decreased 12.6% from that of 1986; unit values increased. Marble was quarried in Talladega County, limestone from an underground mine in Franklin County, and sandstone in Blount County.

Sulfur (Recovered).—Alabama ranked sixth nationally in output of recovered sulfur. Three companies recovered sulfur from natural-gas-processing plants in Escambia, Mobile, and Washington Counties. Two other companies recovered sulfur from petroleum refineries in Mobile and Tuscaloosa Counties. Exxon Co., Hunt Oil Co., Phillips Petroleum Co., and Unocal Oil Co. sold 319,000 metric tons of sulfur valued at $30.6 million, a decrease in output and value. Exxon Co. applied for an air-quality permit to construct a natural-gas-processing facility in Mobile County. The facility was scheduled to start construction in 1988 and produce a byproduct of 450 long tons of sulfur per day.

Talc.—Cyprus Industrial Minerals Co. ground talc for use in cosmetics and pharmaceuticals at its operations near Alpine. Ore was obtained locally and from Montana. Cyprus started development of its Winterboro Mine in June and was expected to reach its capacity in 1988. ADO announced expansions at the Cyprus facility totaling $1 million.

Other Industrial Minerals.—Norton Co., Huntsville, manufactured artificial abrasives at its facility in Madison County; abrasive-grade, high-purity fused aluminum oxide and aluminum zirconium oxide were produced. ADO reported Norton underwent a $400,000 expansion during the year. International Minerals & Chemical Corp. operated a fluosilicic acid plant at Florence. 3 M Corp.'s Specialty Chemicals Div. operated a plant at Decatur that produced a fluoroelastomer used in nonmetallic ducting-system expansion joints. Tennessee Valley Authority and U.S.S. Agri-Chemical Inc. produced anhydrous ammonia at plants at Muscle Shoals and Cherokee, respectively. Annual capacity for the two plants was 249,000 short tons. W. R. Grace & Co., Birmingham, and Armstrong World Industries, Mobile, expanded perlite from ore shipped from the Western United States. Production and value increased over that of 1986. Expanded perlite was used for horticultural purposes and concrete aggregate. W. R. Grace, Irondale, exfoliated vermiculite from ore shipped into Alabama. Major uses were in concrete aggregate, block insulation, loose fill insulation, and as a soil conditioner.

METALS

Primary metal production, once one of the most important industries in the State, has declined over the last decade, with employment dropping 2% in 1987. The primary metals industry in the State consisted of aluminum, ferroalloys, and steel production facilities and various foundries throughout the State.

Aluminum.—Two companies, Revere Copper & Brass Inc., Scottsboro, and Reynolds Metals Co., Sheffield, have facilities for producing aluminum but no production was reported. Reynolds continued to operate the Southern Reclamation Co., which recovered aluminum from scrap cans, and an alloy plant that produced metallic feedstock for aluminum cans. ADO reported expansions by Reynolds at its secondary aluminum and aluminum sheet facility totaling nearly $50 million. Additionally, Southern Reclamation expended $125 million upgrading its facilities. U.S. Die Casting & Development Co. upgraded its aluminum-casting facilities at Sheffield at a cost of $1.6 million.

Kaiser Aluminum & Chemical Corp. closed its 23-year-old wire and cable plant in Bay Minette. A negotiated settlement in 1984, which included a reduction in wages and benefits, guaranteed the plant would remain open 2 years. The closure idled 93 employees.

Bauxite.—Alabama was one of three States producing bauxite. Two companies mined bauxite from pits in Barbour and Henry Counties for use in refractories. Production and value decreased from that of 1986. A. P. Green Refractories was closed throughout the year and sold its reserves to C-E Minerals Inc.

Ferroalloys.—Alabama ranked second nationally in shipments of ferroalloys. Products included ferrosilicon and silicon metal. Moore McCormack Resources Inc. completed the sale of Globe Metallurgical Inc., a silicon and ferrosilicon producer, to a management group backed by Lee Capital Corp., an investment banking firm based in Boston, MA. Globe planned to continue producing silicon metal. ADO reported that Ohio Ferro-Alloys Corp. underwent an expansion program costing $775,000.

Iron Ore.—The Alabama Department of Industrial Relations reported that Pickett

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Machine & Welding Co., Russellville, mined nearly 12,000 short tons of iron ore from the Pickett pit in Franklin County.

Iron and Steel.—Gulf States Steel Corp., Gadsden, and USX Corp., Fairfield, were the only integrated steel-producing companies in the State. Minimills operating included Birmingham Steel Corp., Commercial Metals Co., and SMI Steel Inc. Demand for minimill products remained strong.

Birmingham Steel Corp. purchased minimills in Seattle, WA, and Emeryville, CA, for a total of $37 million. The company completed work on a $3 million finishing mill with plans to install new rolling mill stands by early 1988. Output of Birmingham Steel plants exceed 1 million short tons per year.

CBI Services closed its plate steel fabrication plant in Birmingham early in the year due to decreased demand. The company will consolidate its operations at its facility in Cordova.

Commercial Metals Co., Birmingham, completed an $11 million expansion with the addition of a new rolling mill. Plant capacity was increased from 250,000 short tons per year to 300,000 tons per year.

Gulf States Steel continued a $10 million program to improve facilities at Gadsden. Plans call for a new coil box for the hot-strip mill and computer controls for the hot-strip mill, plate mill, and galvanizing line. The company's problem was that the hot end of the facility could not produce enough steel for the finishing end. Imports of semifinished slabs were required to maintain output.

USX operated at less than capacity during the year. The labor walkout that started mid-1986 ended early in 1987. USX started construction of its second continuous slab caster, which will have a capacity of 1.5 million short tons per year and is scheduled for completion by late 1988. The $200 million project includes modernization of Fairfield's hot-strip mill, enabling production of three major product lines: slab, pipe, and flat rolled products. The caster can produce 104-inch-wide slabs, mainly for Tuscaloosa Steel Corp.'s new rolling mill, as well as narrower slabs for Fairfield's strip mill. USX's rolling mills at Fairfield have more capacity at its hot end than at its finishing end. Tuscaloosa Steel will eventually receive 400,000 short tons of slab per year to supplement about 275,000 tons it now receives from overseas. ADO reported expansions at Tuscaloosa Steel amounting to nearly $10 million.

Other Metals.—Manganese and chromite were ground by Prince Manufacturing Co., Phenix City, formerly N. K. Industries Inc. The product was used mainly for brick colorization. ADO reported Prince installed a second ball mill and related equipment at an expenditure of $120,000. Kerr-McGee Chemical Corp. operated a synthetic rutile plant near Mobile with output shipped to its Hamilton, MS, plant for processing to titanium dioxide pigments. Ilmenite from Australia was used as feed; over 150,000 short tons was imported through the Port of Mobile.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.
[2]State geologist, Geological Survey of Alabama, Tuscaloosa, AL.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum (smelters):			
Revere Copper & Brass Inc	Box 191 Rome, NY 13440	Plant	Jackson.
Reynolds Metals Co	Reynolds Metals Bldg. Richmond, VA 23218	do	Colbert.
Bauxite:			
A. P. Green Refractories Co.,[1] a subsidiary of USG Corp.	Mexico, MO 65265	Mine and plant	Barbour.
Harbison-Walker Refractories Co. Inc.,[2] a division of Dresser Industries Inc.	Dale Rd. Route 1, Box 58 Eufaula, AL 36027	do	Barbour and Henry.
Mullite Co. of America	901 East 8th Ave. King of Prussia, PA 19406	Mines	Do.
Cement:			
Allied Products Co.[3]	Box 36130 Birmingham, AL 35236	Plants	Jefferson and Shelby.
Blue Circle Inc.[4]	Box 182 Calera, AL 35040	Plant	Shelby.
Citadel Cement Corp	2959 Paces Ferry Rd., Suite 7 Atlanta, GA 30339	do	Marengo.

See footnotes at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Cement —Continued			
Ideal Basic Industries Inc.[4]	950 17th St. Box 8789 Denver, CO 80201	Plants	Mobile.
Lehigh Portland Cement Co	Box 1882 718 Hamilton Mall Allentown, PA 18105	Plant	Jefferson.
National Cement Co. Inc	Box 7348 Mountain Brook Station Birmingham, AL 35223	do	St. Clair.
Clays:			
Bickerstaff Clay Products Co. Inc	Box 517 Bessemer, AL 35020	Mines	Jefferson and Russell.
Blue Circle Inc	Box 182 Calera, AL 35040	Mine	Shelby.
Jenkins Brick Co	Box 91 Montgomery, AL 37101	Mines	Chilton, Elmore, Montgomery.
Livlite Corp	Drawer V Livingston, AL 35470	Mine	Sumter.
Ferroalloys:			
Interlake Inc., Globe Metallurgical Div.	Box 348 Selma, AL 36701	Electric furnace	Dallas.
International Minerals & Chemical Corp., TAC Alloys Div.	Garner Rd. Bridgeport, AL 35740	do	Jackson.
Ohio Ferro-Alloys Corp	Box 68 Montgomery, AL 36057	do	Montgomery.
Reynolds Metals Co	Box 191 Sheffield, AL 35660	do	Colbert.
Lime:			
Allied Products Co	Box 268 Alabaster, AL 35007	Plant	Shelby.
Dravo Lime Co	One Gateway Center Seventh Floor Pittsburgh, PA 15222	do	Do.
Pig iron:			
Gulf States Steel Corp	174 South 26th St. Gadsden, AL 35901	Furnaces and mills.	Etowah and Jefferson.
USX Corp	Box 599 Fairfield, AL 35064	do	Jefferson.
Jim Walter Resources Inc	330 1st Ave., North Birmingham, AL 35202	Furnaces	Do.
Salt:			
Olin Corp	120 Long Ridge Rd. Stamford, CT 06904	Brine wells	Washington.
Sand and gravel (1986):			
Holland and Woodward Co. Inc	Box 1947 Decatur, AL 35601	Surface mine and plant.	Franklin.
R & S Materials Inc	Box 3547 Montgomery, AL 36109	do	Autauga, Elmore, Montgomery.
Southern Industries, Radcliff Materials.	Box 2068 Mobile, AL 36601	do	Mobile and Montgomery.
C. T. Thackston Sand & Gravel Inc.	Box 3211 Montgomery, AL 36109	do	Montgomery.
Stone:			
Allied Products Co	Box 628 Alabaster, AL 35007	Quarries	Jefferson and Shelby.
Dolcito Quarry Co	Box 6566 Birmingham, AL 35217	Quarry	Jefferson.
Ideal Basic Industries Inc	950 17th St. Box 8789 Denver, CO 80201	do	Monroe.
Southern Stone Co. Inc.[5]	Box C-200 Birmingham, AL 35283	Quarries	Jefferson, Lee, Shelby.
Vulcan Materials Co.[6]	Box 7324-A Birmingham, AL 35253	do	Calhoun, Colbert, Etowah, Franklin, Jackson, Jefferson, Madison, Morgan, Shelby.
Talc:			
Cyprus Industrial Minerals Co	Alpine, AL 35014	do	Talladega.

[1]Also kaolin.
[2]Also kaolin and synthetic mullite.
[3]Also lime.
[4]Also clays and stone.
[5]Also sand and gravel.
[6]Also clays and sand and gravel.

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The Mineral Industry of Alaska

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Divison of Geological and Geophysical Surveys, Alaska Department of Natural Resources, for collecting information on all nonfuel minerals.

By Tom L. Pittman[1]

The value of nonfuel mineral production reported in Alaska in 1987 was $125.3 million; in 1986 the value was $91.5 million. The increase was due mainly to the increased production of gold and increased value of construction sand and gravel. Alaska ranked 40th in the value of nonfuel mineral production, improved from 42d in 1986. The increased gold production was due to expanded operations by several of the large placer mines. The number of mechanized placer gold mines was about 200, almost the same as in 1986, but about 25% below the number of mines operating in 1985.

The lawsuits against the U.S. Bureau of Land Management (BLM) and the National Park Service contesting their management practices and oversight of mining operations on Federal lands continued to be of major concern to many placer operators. The U.S. Army Corps of Engineers was requiring permits for mining operations on wetlands and streams because of a request by the U.S. Fish and Wildlife Service and the threat of a lawsuit by an environmental organization. A legal challenge to the mining location and leasing system on State lands was another major concern. Water-quality guidelines and regulations of the U.S. Environmental Protection Agency and of the Alaska Department of Environmental Conservation caused continuing problems, especially for small-scale operators.

Table 1.—Nonfuel mineral production in Alaska[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	e$60	NA	$25	NA	$86
Gold (recoverable content of ores, etc.) troy ounces	44,733	14,210	48,271	17,775	86,548	38,769
Sand and gravel (construction) thousand short tons	e29,000	e63,000	27,762	61,954	e27,200	e73,400
Silver (recoverable content of ores, etc.) thousand troy ounces	W	W	W	W	10	70
Stone (crushed) thousand short tons	1,907	8,535	e2,000	e8,500	2,033	8,945
Combined value of cement (portland), tin, and values indicated by symbol W	XX	4,164	XX	3,226	XX	4,010
Total	XX	89,969	XX	91,480	XX	125,280

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Alaska in 1986, by region[1]

Region	Minerals produced in order of value
Bristol Bay	Sand and gravel (construction).
Cook Inlet-Susitna	Gold, sand and gravel (construction), cement, silver.
Copper River	Sand and gravel (construction).
Kenai Peninsula	Do.
Seward Peninsula	Gold, tin, silver.
Southeastern Alaska	Sand and gravel (construction).
Yukon River	Sand and gravel (construction), gold, silver.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for regions not listed.
[2]Data not available by region for minerals listed.

Trends and Developments.—There was a sharp increase in staking of new mining claims in 1987, following a drop from 1985 to 1986. There were 6,773 claims in 1985, 5,315 in 1986, and 8,276 in 1987. Most of the new claims were located for precious metals. Total active claims dropped from 81,782 in 1985 to 68,348 in 1987, indicating abandonment of many base-metal claims. The search for platinum-group metals in placer and lode deposits continued, and interest in lode gold and silver deposits increased. There was more activity in the exploration and development of placer deposits for extraction by underground mining methods.

The results of State surveys of the mining industry were published in Alaska's Mineral Industry, 1987—Special Report 41.[3] This report was produced and distributed by the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys (DGGS) and Division of Mining; and the Department of Commerce and Economic Development, Division of Business Development. State surveys show nonfuel mineral exploration expenditures in 1987 almost double the expenditures in 1986. Southeastern, Eastern Interior, and South-Central regions were the most active. Expenditure on exploration in 1987 was estimated at about $14.6 million, up from about $8.9 million in 1986. Development in 1987 was about $99.9 million, almost four times the $23.8 million estimate for 1986. The 1987 development outlay was the largest in any year in the history of the Alaska mineral industry. Principal development expenditures were in the Northern, Southeastern, and Eastern Interior regions.

State surveys estimated nonfuel mineral production at $159.7 million in 1987, with the value of metal production exceeding the value of industrial mineral production for the first time in 20 years. Gold production was estimated to have increased more than 70% over that of 1986. In the Western region, a large offshore dredge, two upland floating dredges, and a large mechanized sluicing operation accounted for the largest increase in gold output. There were moderate increases in gold production in the South-Central and Eastern Interior regions. Continued development of the Red Dog zinc-lead mine north of Kotzebue and the Greens Creek silver-gold-zinc-lead mine on Admiralty Island were among the most important mining developments in the State.

Employment.—The nonfuel mineral industries employed 3,172 people in 1987, an increase from 2,950 people in 1986. The State employment statistics include seasonal and year-round jobs. Distribution of these people are as follows: mechanized gold mining, 39%; construction sand and gravel, 26%; mineral development, 13%; recreational mining and assessment work, 7%; stone, 6%; coal, 4%; mineral exploration, 3%; and miscellaneous lode and other mineral production, 2%.

Exploration Activities.—Exploration for precious metals deposits was widespread in Alaska. Most of the major projects were in historic mining areas that were formerly the most significant producers of placer or lode gold.

Nonfuel mineral exploration expenditures were $14.6 million, up from $8.9 million in 1986, according to the State surveys. About 80% of the exploration money was used in the search for precious metals. Lode gold activity exceeded placer activity in each of the seven regions, with expenditures of about $5 million in the Southeastern, $1.5 million in the Eastern Interior, $1.3 million in the South-Central, and $1.1 million in the Western region. About 31,300 person-days of employment were provided by nonfuel exploration.

Nonfuel mineral drilling footage in 1987 was 295,300, a decrease from the 1986 total of 309,600 feet drilled. Placer drilling was 180,000 feet in 1987, down from 259,400 feet in 1986. The decrease was mostly due to the need for less thaw-field drilling by Alaska Gold Co. ahead of its Nome dredges after the extensive drilling in 1986. Placer exploration drilling increased from 32,000 feet in 1986 to 50,250 feet in 1987, about evenly divided between the Seward Peninsula

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and the Valdez Creek Mine east of Cantwell. Alaska Gold drilled about 130,000 feet of thaw-field holes to keep unfrozen ground ahead of its two gold dredges. Hardrock drilling increased to 115,100 feet, from the 50,200 feet drilled in 1986. More than 96% of the 1987 footage was drilled on precious metals deposits. Major drilling projects were carried out by 16 companies, up from 8 companies in 1986. About 36,800 feet was drilled in Southeastern Alaska and 29,000 feet in Interior Alaska.

Legislation and Government Programs.—The 52-mile Pioneer Road from the portsite on the Chukchi Sea to the Red Dog Mine was contracted to Enserch and financed by the Alaska State Industrial Development and Export Authority. The State revenue bonds will be repaid by Cominco Alaska Inc. This road will be upgraded to State design standards in 1988 and become part of the DeLong Mountains Transportation System.

On March 30, the Governor assigned priority status to water-quality issues and directed the Commissioners of Natural Resources, Fish and Game, and Environmental Conservation to address Federal and State regulatory and legal problems that adversely affect the mining industry. Improved practices by mine operators and regulatory actions by State and Federal agencies had improved streamwater quality in most placer mining areas. About 97% of the placer mines met the Federal settleable solids standard of 0.2 milliliter per liter. The State turbidy standard of 5 nephelometric turbidity units was met by only a few placer mines with low amounts of clay and silt in their sluice feeds and stripped overburden.

More than 20 bills and resolutions of interest to the mineral industries were introduced in the first session of the 1987-88 legislature. The only bill passed and signed into law by the Governor would provide penalties for giving false information or making false reports. The other bills were carried over to the second session of the legislature.

A study group was formed by the Department of Environmental Conservation and the Alaska Miners Association to determine options available to implement water-quality regulations. Proposals by the study group and private groups have been referred to the Attorney General for compliance with the Clean Water Act. A lawsuit by the Sierra Club against BLM resulted in an injunction by a Federal judge in the U.S. District Court for Alaska early in 1987. The order prohibited BLM from permitting any mining operation that disturbed more than 5 acres in the Beaver Creek, Birch Creek, Chatinika River, and Fortymile River drainages. Preparation of environmental impact statements on these drainages by BLM may take up to 3 years and halt the larger mining operations in these areas until the injunction is withdrawn.

The Army Corps of Engineers will require permit applications from most mining operators for activity in the 1988 season. The Corps will determine if the applicant will be operating on lands under its jurisdiction and proceed with permitting if wetlands or streams are affected. Many miners were concerned that permits would be available too late for them to mine in the 1988 season. It was unknown how much of the muskeg that covered much of the surface of the State would be officially classified as wetlands by the Corps.

The U.S. Minerals Management Service started preparations to lease about 350,000 acres of offshore Federal lands in Norton Sound from 3 to 12 miles south of the Seward Peninsula and from about 52 miles east to 14 miles west of Nome. The exploration of some of the State offshore lands and the successful recovery of placer gold from these lands by the "BIMA" bucketline dredge had created interest in the area. Examination and geologic mapping of the Steese-White Mountains National Recreation Area was completed by the DGGS, under contract to the U.S. Geological Survey (USGS). A report released late in 1987 indicated resources of gold, silver, tin, and rare-earth elements. Placer resources in the Steese Recreation Area were evaluated by the U.S. Bureau of Mines. The Bureau and the DGGS continued geologic mapping and mineral examinations in the Haines and Skagway areas. The Bureau continued work in the Juneau mining district and "Gold Belt," the Valdez Creek project area, and on various strategic and critical minerals projects.

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REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Gold.—Gold production reported to the U.S. Bureau of Mines in 1987 was 86,548 troy ounces valued at $38.8 million. This production, reported by 15 placer and 2 lode operators, was believed to be less than 40% of actual 1987 production. State surveys estimated gold production at about 229,700 ounces valued at $104.5 million, up from 160,000 ounces valued at $60.8 million in 1986. State production estimates for 1987 are "based on data compiled from 177 questionnaires returned from private companies, responses to a telephone survey of 35 companies that mine sand and gravel and 5 that extracted stone, and information provided by the Bureau of Mines, USGS, University of Alaska, precious metal refiners, and consultants," according to Special Report 41. The gold was recovered by 202 placer mines and 3 small lode mines, compared with 196 mechanized placer mines in 1986. The 10 largest placer mines produced about 58% of the gold in 1987.

The State estimated 79 placer and 2 lode mines produced 50,696 ounces of gold in 1987 in the Eastern Interior region, employing about 380 people. The largest producers were GHD Resources Partners Ltd. on Eagle Creek and V. F. Halverson with M. D. Wolters on Mammoth Creek, in the Circle district.

The Western region reported 46 mining operations that produced about 44% of the total gold in 1987. About 70% of the statewide increase over 1986 production occurred in this region. The Western Gold Exploration and Mining Co. (WestGold) operated its 33-cubic-foot bucketline dredge, the BIMA, on State offshore leases near Nome. From June 16 to November 23, when it went to Nome for the winter, the dredge recovered about 36,000 ounces of gold. WestGold employed 124 people for production and from 65 to 70 during the winter layup for repair and maintenance. Alaska Gold Co. operated two 9-cubic-foot bucketline dredges upland on old raised beaches, employing 133 people. The company successfully stripped frozen overburden in 1987 and planned to continue the practice. Gold production in 1987 was about double that in 1986 when one dredge did not operate.

Windfall Gold Mining Corp. mined on the upland Third Beach, about 3 miles north of Nome, on ground leased from Alaska Gold. Scrapers and loaders were used to work a complex paystreak that could not be mined in a former operation by Alaska Gold's Dredge No. 3. Windfall also produced −4+1/2-inch gravel from tailings for sale to various users.

Several other fairly large-scale placer mines, and many small mines, operated on the Seward Peninsula, in the Ruby-Poorman District, Kaihyu Hills, Tolstoi, and other areas.

In the Fairbanks District, 19 placers and 2 lode mines produced an estimated 21,119 ounces of gold, according to the State survey. Placer mines employed 158 people and 53 worked at lode mines. The largest operators in the district were Polar Mining Inc. on Sheep Creek and Sphinx America Inc. on Fish and Fairbanks Creeks. Both operators drilled, blasted, and stripped frozen overburden during the winter. The heap-leach mine on the Ryan Lode west of Fairbanks produced about 6,100 ounces of doré bullion, according to Citigold Alaska, recovering about 40% of the gold on its two pads; leaching was to continue in the 1988 season. The Tenderfoot District reported minor production from two drift mines and three surface placers. Alaska Unlimited Co. operated the largest placer mine in the Bonnifield District south of Fairbanks. About 20 formerly producing placers were idle in the Coal Creek, Kantishna, and Woodchopper areas. The National Park Service could not issue plans of operation until individual and cumulative environmental impact assessments were completed, as required by the Sierra Club court case.

In the South-Central region, the State estimated that 29 placer mines recovered 46,460 ounces of gold, employing about 250 people. The largest mine was operated by Valdez Creek Mining Co. Inc. east of Cantwell. Gold production in 1987 was 33,277 ounces. The company had an enclosed washing plant and operated all year with about 135 people. It reported it could operate its washing plant, haulage, and water recycling units until the temperature reached about −35° F. At that point, operating costs would be too high. The mine was the top gold producer in the State in 1987. Two mines ceased operation in the Wrangell-St. Elias National Park because the National Park Service could not issue permits.

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The Southwestern region produced 20,000 ounces of gold from 36 placer mines, as reported to the State. About 130 persons were employed. Water shortages plagued some operators. Placers were worked on Ganes, Spruce, Anvil, Ester, and Yankee Creeks in the Innoko District, and on Flat Creek in the Iditarod District. The largest placer in the Aniak District was operated by Tuluksak Dredging Inc., whose 5-1/2-cubic-foot bucketline dredge dug and washed 5,000 cubic yards per day for 140 days, from June to the last week in October.

The Northern region reported eight companies produced 7,256 ounces of gold, almost double the mines and production in 1986. These companies mined on Tobin Creek, Hammond River, Gold Creek, Linda Creek, and Archibald, Nolan, and Vermont Creeks.

The State reported five operators produced 3,400 ounces of gold in the Southeastern and Alaska Peninsula regions. Gulf of Alaska strandline beach sands were processed to recover gold and a garnet concentrate. The garnet product may have commercial promise as an abrasive. A gold heap-leach operation on the south side of Ester Dome, east of Fairbanks, was being developed. Also on Ester Dome, Citigold Alaska continued development of a heap-leaching operation. Already completed were two lined 50,000-ton leaching pads, an agglomerating plant, and an activated-carbon precipitation and gold recovery unit. About 6,100 ounces of gold-silver bullion was produced in the 1987 season, and leaching was to continue in the summer of 1988. Citigold Alaska claimed drill-indicated reserves of 2 million tons of ore averaging 0.13 ounce of gold per ton along a strike length of 2,000 feet.

Placer gold development expenditures reported by the State were $1.5 million, down from $11 million reported in 1986. Most of the expenditures were for new recovery plants, water clarification and recycling systems, camps, and some overburden stripping. Significant developments occurred in the South-Central, Eastern Interior, and Western regions. There was an increase in interest and activity in drift mining. Ten companies reported activities ranging from portal construction, shaft sinking, and development drifting in drilled reserves, through experimenting with various mining methods to determine economic viability. Five of these companies were in the Fairbanks mining district, two in the Wiseman District, and one each in the Innoko, Richardson, and Livengood Districts.

Tolstoi Mining Co. continued underground development of platinum-gold reserves and reported some production at its mine on Boob Creek in the Innoko District, using steam points for thawing permafrost.

Other Metals.—The Red Dog zinc-lead mine project expended or committed about $140 million toward development in 1987, about 40% of the estimated 4-year development-and-equipment cost. With the pioneer road completed, camp facilities were installed at the minesite. Monies were obligated for construction, mine and mill equipment contracts, and other development services and purchases. About 400 people worked on the road and at the project site in 1987. In 1988, from 350 to 400 people would be working on construction activities. Green Construction Co. stored construction equipment at the port in 1987 and would move its units to the minesite in 1988. Green contracted to build tailings and freshwater dams, prepare the millsite, construct roads from the airstrip to the minesite, and start stripping the ore body.

The Red Dog Mine was owned by the NANA Regional Corp. and operated by Cominco Alaska. The mine is situated about 90 miles north of Kotzebue, in the Northern region. Published reserves for the open pit ore body were 85 million tons averaging 17.1% zinc, 5.0% lead, and 2.4 ounces of silver per ton. The proposed milling rate was about 6,000 tons per day, producing about 550,000 tons of zinc concentrate, 100,000 tons of lead concentrate, and 50,000 tons of polymetallic concentrate per year. Cominco Alaska had placed long-term contracts for processing concentrates at smelters in Canada, Europe, and Asia. Production was scheduled to start early in 1990 and concentrate shipments to begin that summer.

The Greens Creek Mining Co. approved full development of the Greens Creek silver-gold-zinc-lead mine in June. Planned production was 1,000 tons per day from an underground mine, using drift-and-fill and cut-and-fill stoping methods. In 1986, a 9-mile road was constructed from the portsite at Hawk Inlet to the mine and millsite on Greens Creek, and a main haulage adit was started. In 1987, a 5-mile road was built from Youngs Bay on the east side of Admiralty Island to Hawk Inlet on the west side of the island. Employees would commute from Juneau to Youngs Bay by company ferry and by bus to the mine. The mine is

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about 18 air miles from Juneau. The haulage adit and drifts were advanced about 2,500 feet, and about 3,000 feet of diamond drilling was completed from underground stations on that level. Production was scheduled to start early in 1989 at 1,000 tons per day. The flotation mill would have a gravity circuit to recover coarse gold. Concentrates would be shipped out to various smelters. The operating work force would be about 200.

Development costs were estimated at $105 million. Published proven recoverable reserves were 3.5 million tons averaging 24 ounces of silver per ton, 0.18 ounce of gold per ton, 9.7% zinc, and 3.9% lead, with small amounts of copper. Greens Creek, the operator, was a subsidiary of BP Minerals America Inc. The joint-venture partners were BP (53.1%), Hecla Mining Co. (28%), CSX Oil and Gas Corp. (12.6%), and Exalas Resources (6.3%). Amselco Minerals Inc., the former operator, was a subsidiary of BP North America Inc. and was absorbed by BP.

To promote local hire and a stable work force, Greens Creek and the University of Alaska Southeast established training classes in the skills needed by the mining and milling operations. More than 100 people would be trained in Juneau for entry-level jobs in 1987 and 1988. The Greens Creek operation is situated in a nonwilderness portion of the Admiralty National Mounment and in the Tongass National Forest. It is a good example of a mining operation that has developed successfully within the limits of strict environmental regulations and constraints.

A small amount of mercury was produced by James Wiley at the Mountain Top Mine, about 35 miles southwest of Sleetmute. Silver was produced as a natural alloy with placer and lode gold. The State canvass reported 1987 production at 54,300 ounces, valued at $390,960, an increase from 24,000 ounces valued at $134,400 reported in 1986.

Lost River Mining recovered placer tin in a cassiterite concentrate from Cape Creek, on the Seward Peninsula. Production was reported to the U.S. Bureau of Mines and to the State. In Special Report 41, the State published a 1987 production figure of about 288,000 pounds of equivalent refined tin, valued at $460,000. Reported tungsten production in 1987 was listed as 160 short ton units valued at $11,400; in 1986, it was 120 short ton units worth $22,800.

INDUSTRIAL MINERALS

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1986 and estimates for 1985 and 1987. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel production was estimated at about 27.2 million short tons valued at $73.4 million. Production in 1986 was 27.8 million tons valued at $62 million. The State survey listed production in 1987 at 16.7 million tons valued at $42.7 million, down from 20.9 million tons worth $75.7 million in 1986. Production and value of sand and gravel were influenced by intensified competition among producers, a weak Alaskan economy, and reduced infrastructure development on Alaska's North Slope oilfields. North Slope oil-related activities listed only three drill pads constructed and minor road and other projects using about 660,000 tons of sand and gravel. Enserch Alaska Services mined about 2.8 million tons of aggregate, borrow, and shot rock; 110,000 tons of sand; and 2,400 tons of riprap to construct the Red Dog Mine road, according to the State survey. State and Federal road projects consumed about 40% of the sand and gravel produced in 1987. In the Eastern Interior region, 14 producers reported 6 million tons of production in 1987, a decrease from 7.1 million tons in 1986. Construction for the U.S. Army Light Infantry Division at Fort Wainwright, near Fairbanks, helped sustain production in this region.

The South-Central region produced about 4.3 million tons of construction sand and gravel, considerably lower than the 5.4 million tons in 1986. Consumption decreased about 50% in the Anchorage area but increased on outlying road rerouting and construction projects. Anchorage Sand and Gravel Co.'s Palmer pit supplied about one-half of the 1.8 million tons of sand and gravel hauled by the Alaska Railroad. About 862,0000 tons of sand and gravel were mined in the Southeastern region, up from about 510,000 tons mined in 1986. Nearly 360,000 tons of mixed aggregate and fill were used for construction projects at the Greens Creek Mine. About 420,000 tons of borrow and aggregate were used by the State for road maintenance and allied purposes.

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Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed and broken stone reported to the U.S. Bureau of Mines in 1987 was 2 million short tons valued at $8.9 million, little changed from that of 1986. Values were higher for construction in several remote areas.

Table 3.—Alaska: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	136	501
Fine aggregate (-3/8 inch): Stone sand, bituminous mix or seal	W	15
Coarse and fine aggregates:		
Graded road base or subbase	94	297
Unpaved road surfacing	1,425	6,336
Crusher run or fill or waste	38	264
Other construction[2]	134	596
Special: Other unspecified[3]	205	936
Total	[4]2,033	8,945

W Withheld to avoid disclosing proprietary data; included with "Other Construction."
[1]Includes limestone, granite, sandstone, traprock, and miscellaneous stone.
[2]Includes macadam, filter stone, concrete aggregate (coarse), bituminous aggregate (coarse), railroad ballast, stone sand (concrete), stone sand (bituminous mix or seal), and data indicated by symbol W.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Other Industrial Minerals.—Anchorage Sand and Gravel continued to operate its cement plant, using domestic clinker and gypsum shipped to Anchorage. The company also operated a modern concrete-block plant and ready-mixed concrete facilities. The State reported horticultural peat production in 1987 at 46,000 cubic yards valued at $299,000. In 1986, the volume reported was 50,000 cubic yards worth $350,000. About 60% of the peat was produced by Great Northern Landscaping of Fairbanks. Gem stones produced in Alaska were jade, soapstone, epidote crystals, petrified wood, and various other minerals and materials in minor amounts.

[1]State Mineral Officer, Bureau of Mines, Juneau, AK.
[2]Bundtzen, T. K., C. B. Green, R. J. Peterson, and A. F. Seward. Alaska's Mineral Industry, 1987. Div. of Geol. and Geophys. Surv., Spec. Rep. 41, 1988, 69 pp.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	Region
Cement (portland):			
Anchorage Sand and Gravel Co	1813 East First Ave. Anchorage, AK 99501	Grind and blend.	Cook Inlet-Susitna.
Gold:			
Alaska Gold Co	Box 640 Nome, AK 99762	Placer-dredge	Seward Peninsula.
Alaska Placer Development Inc. (Hanneman-Knaebel Partnership).	Box 81467 Fairbanks, AK 99708	Placer	Yukon River.
GHD Resources Partners Ltd	Box 10499 Fairbanks, AK 99710	do	Do.
Valdez Creek Mining Co. Inc	610 East 4th Ave. Anchorage, AK 99507	do	Do.
Western Gold Exploration and Mining Co.	Box 1210 Nome, AK 99762	Placer-dredge	Seward Peninsula.
Windfall Gold Mining Corp	Box 1920 Nome, AK 99762	Placer	Do.
Sand and gravel (construction):			
Anchorage Sand and Gravel Co	1813 East First Ave. Anchorage, AK 99501	Pit	Cook Inlet-Susitna.
Central Paving Products	1301 East 64th Ave. Anchorage, AK 99501	Pit	Do.
Fairbanks Sand and Gravel Co	Box 686 Fairbanks, AK 99707	Pit	Yukon River.
Juneau Ready-Mix Inc	Box 270 Juneau, AK 99802	Pit	Southeastern Alaska.
U.S. Bureau of Land Management	Box 13, 701 C St. Anchorage, AK 99513	Pit	Various.

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Table 4.—Principal producers —Continued

Commodity and company	Address	Type of activity	Region
Stone:			
Alaska Railroad Corp	Box 107500 Anchorage, AK 99510	Pit	Various.
Aleutian Constructors	3909 Arctic Blvd. Anchorage, AK 99501	Quarries	Cook Inlet-Susitna.
Associated Sand & Gravel Co. Inc	Box 3699 Juneau, AK 99803	do	Southeastern Alaska.
U.S. Forest Service, Region 10	Box 1628 Juneau, AK 99802	do	Various.
South Coast Inc	Box 8620 Ketchikan, AK 99901	Quarry	Southeastern Alaska.
Yutan Construction Co	Box 1775 Fairbanks, AK 99707	do	Yukon River.
Tin:			
Lost River Mining	Box 411 Nome, AK 99672	Placer	Seward Peninsula.

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The Mineral Industry of Arizona

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Arizona Department of Mines and Mineral Resources for collecting information on all nonfuel minerals.

By Michael N. Greeley[1]

Arizona's nonfuel mineral production rose in 1987 to $1.8 billion. This represents an increase of more than $200 million or about 15% over that of 1986. Containing diversified mineral resources, the State ranked second nationally in the value of its nonfuel production.

Leading the Nation in the production of copper, Arizona is also among the top producers of bentonite, cement, gem stones, lime, molybdenum, rhenium, sand and gravel, silver, and sulfuric acid. Copper was the principal commodity produced in terms of value, accounting for almost $1.4 billion or about 78% of the total nonfuel mineral value produced in the State.

Table 1.—Nonfuel mineral production in Arizona[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	186	$1,503	201	$1,366	218	$1,905
Copper (recoverable content of ores, etc.) metric tons	796,556	1,175,995	789,175	1,149,193	764,148	1,389,771
Gem stones	NA	e2,700	NA	2,533	NA	3,000
Gold (recoverable content of ores, etc.) troy ounces	52,053	16,535	W	W	95,240	42,663
Gypsum thousand short tons	251	1,926	260	1,820	W	W
Lead (recoverable content of ores, etc.) metric tons	581	244	W	W	--	--
Lime thousand short tons	476	21,226	505	21,016	546	21,932
Molybdenum thousand pounds	24,125	63,389	29,382	75,607	W	W
Perlite short tons	W	W	W	W	49	1,361
Pumice thousand short tons	W	2	2	30	1	7
Sand and gravel (construction) do	e37,000	e118,000	40,468	140,004	e38,100	e141,300
Silver (recoverable content of ores, etc.) thousand troy ounces	4,885	30,007	r4,506	r24,649	3,667	25,706
Stone (crushed) thousand short tons	5,929	23,111	e5,600	e25,100	7,712	33,999
Combined value of cement, pyrites (1985, 1987), salt (1986-87), sand and gravel (industrial), stone (dimension), and values indicated by symbol W	XX	95,447	XX	r118,505	XX	129,399
Total	XX	1,550,085	XX	r1,559,823	XX	1,791,043

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Arizona in 1986, by county[1]

County	Minerals produced in order of value
Apache	Clays, sand and gravel (construction).
Cochise	Copper, sand and gravel (construction), gold, silver.
Coconino	Sand and gravel (construction).
Gila	Copper, molybdenum, sand and gravel (construction), clays.
Graham	Sand and gravel (construction), pumice.
Greenlee	Copper, gold, silver, molybdenum, sand and gravel (construction).
La Paz	Sand and gravel (construction).
Maricopa	Sand and gravel (construction), salt, gold, clays, silver.
Mohave	Sand and gravel (construction), gold.
Navajo	Sand and gravel (construction).
Pima	Copper, cement, molybdenum, sand and gravel (construction), silver, gold, clays, lead.
Pinal	Copper, sand and gravel (construction), molybdenum, gold, silver, gypsum, perlite, clays.
Santa Cruz	Sand and gravel (construction).
Yavapai	Copper, cement, lime, molybdenum, sand and gravel (construction), silver, gypsum, clays, gold.
Yuma	Sand and gravel (construction).
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—In general, the mining industry began to show signs of improvement in 1987. In a concerted effort to cut costs, the copper producers continued to restructure their organizations and improve productivity. Acquisition was common through purchase of known copper reserves and active production. Costly smelter operations were either closed or modernized and relatively inexpensive hydrometallurgical plants were installed or enlarged.

Almost one-fifth of all copper produced in the State was recovered by leaching oxide ores and low-grade dumps. This low-cost technology has received increasing use by the copper companies.[2] The production of copper by cementation decreased more than 30% in 1987.

These company policies and developments laid the foundation for higher profits and dividends when the price of copper began to rise. Miners received voluntary disbursements and bonuses mandated by labor contracts negotiated in 1986. Over $17 million was distributed by the copper companies to approximately 6,100 workers for 1987.

Prospectors and mine developers continued to show an increased interest in the gold potential of Arizona. Claim staking, particularly in the western part of the State, was heavy. Records maintained by the Bureau of Land Management rank Arizona third among the States in the number of active claims for all commodities. Unlike the recent past when gold was recovered principally as a byproduct of copper or silver mines, approximately one-half of the production is now from primary sources.

Production of industrial minerals continued to improve in the State. Interest in clays, gem stones, gypsum, lime, perlite, and salt remained high. There was a marked increase in the production of crushed stone.

Employment.—An annual average of 11,100 workers was employed in the Arizona mining industry.[3] This figure, a slight increase over that of 1986, includes workers in the mineral fuels industry. Over 80% of this total work force is in copper exploration and production. The number of miners and other employees in the copper industry, averaging 8,900 during 1987, was reduced as the mining companies continued cost-cutting measures and exported smelting to other States. The smelter at Douglas, owned by the Phelps Dodge Corp., was closed permanently on January 15.

The mining industry of Arizona provided a total income to its workers of $422.9 million. The copper industry contributed $254.1 million (60%) to this total. The average weekly earnings of a mining company employee, $584, were the highest in the State's industrial sector.

Legislation and Government Programs.—The Arizona State Legislature agreed in Senate bill (S) 1317 to provide limited funds to the office of the State Mine Inspector to locate and quantify the danger of mine openings. Attention was to be paid initially to mining districts close to major urban areas.

State legislation (S. 1102) was enacted to create, effective July 1, 1988, the new Arizona Geological Survey in Tucson. This agency was formed by separating the Geologic Branch of the Arizona Bureau of Geology and Mineral Technology from the University of Arizona. The Mineral Technology Branch remained with the university under the administration of the College of Engineering and Mines. The director of the new agency serves officially as the State geologist and is appointed directly by the Governor of the State.

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Effective August 17, 1987, new regulations governing certain location requirements when staking lode, placer, and millsite claims were promulgated by the Arizona State Legislature (S. 1125). The new law requires the location monument of a lode claim to be placed on the center line instead of at a corner. Monumenting requirements have been changed to eliminate the need for end-center monuments on placer and millsite claims. Additionally, government survey markers are no longer acceptable as a claim monument.

Late in the year, an important decision affecting mine development on State lands was rendered by the Arizona Supreme Court. This decision declared unconstitutional the current law that sets a flat royalty rate paid by miners who operate on trust lands leased from the State. Until appeals are filed and decisions made in the courts or new legislation is passed or both, the status of mineral leases on State lands is thrown into uncertainty. As a further consequence, mineral explorers are reluctant to obtain new prospecting permits on State lands.

In 1987, the U.S. Congress approved a proposal submitted by the University of Arizona to share the cost of establishing the Center for Advanced Studies for Copper Recovery and Utilization. The Federal share is $4 million. Primary objectives of the research are threefold: (1) in situ copper leaching, (2) recovery of byproduct copper leach solution, and (3) use of copper and byproduct in the preparation of high-tech materials. The research will be conducted in Tucson under the direction of the Department of Materials Science and Engineering, College of Engineering and Mines.

The Congress also directed the U.S. Bureau of Mines to evaluate several buried, predominantly oxide, copper deposits in Arizona for their amenability to in situ leaching. In situ leaching was identified by the Bureau as a modern development in technology that may have wide application for lowering costs, increasing productivity, and reducing environmental pollution within the mining industry. Essentially all of 1987 was used to develop and prepare a manual of generic in situ copper mine design and to examine several proposed sites for field testing.

An additional project of the Bureau was to conduct research on solution flow modeling and detection. A hydrologic program entitled MINFLO was developed and tested at the in situ leach operation at the San Manuel Mine (Pinal County). The leach solutions are injected, via wells drilled from the surface, into rubbled oxide ore. Leachate is recovered in underground workings. The MINFLO model was applied to analyze flow characteristics of the broken ore mass and volume discrepancies between injected and recovered solutions.

During the year, the Bureau issued two open file reports addressing mineral land assessments in Arizona. These reports summarized mineral evaluations of wilderness study areas (WSA) under the jurisdiction of the Bureau of Land Management. Base and precious metal anomalies were described in the Ragged Top WSA of Pima County.

The Arizona Department of Mines and Mineral Resources published "Arizona Mineral Development, 1984-86" and a revised "Arizona Industrial Minerals." The Arizona Bureau of Geology and Mineral Technology, Geologic Branch, published "Proceedings of the 21st Forum on the Geology of Industrial Minerals," "Geologic Diversity of Arizona and Its Margins," and "Compilation of Radiometric Age Determinations in Arizona." This State agency also issued an open file report entitled "Summary of a Workshop on the Search for Unconventional Ore Deposits in Arizona."

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Copper.—Arizona continued to rank first in the Nation in copper production with over 60% of the total domestic output. More than 1.6 billion pounds was produced in 1987 and the red metal accounted for more than three-fourths of the State's nonfuel mineral value. There were 12 principal copper mine operations. Although 1987 copper production in Arizona decreased slightly, increasingly tight supplies resulted in a dramatic rise in prices during the second half of the year. There was an ultimate 21% rise in the annual value of copper produced as compared with that of 1986.

Several steps were taken by the producers to reduce costs and improve productivity and competitiveness during one of the longest downturns ever experienced in the industry. In addition to cutting the work force in Arizona by more than one-half, the in-

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dustry eliminated the automatic cost-of-living adjustment and reduced benefit provisions. Working from this base of labor-related savings established in the early to mid-1980's, firms rapidly initiated corporate restructuring and innovative mining and metallurgical technology.

Table 3.—Arizona: Material handled and copper produced at 16 leading copper open pit and underground mines

Mine	Ore mined (thousand metric tons)		Waste material removed (excluding material placed in leach dumps) (thousand metric tons)		Material placed in leach dumps (thousand metric tons)		Total copper produced[1] (metric tons)	
	1986	1987	1986	1987	1986	1987	1986	1987
OPEN PIT								
Morenci	W	36,149	NA	--	NA	--	W	247,756
Ray	9,874	10,859	--	--	20,949	21,562	90,848	97,692
Pinto Valley	20,172	W	79,995	NA	177,664	NA	81,664	W
Sierrita	[2]26,928	26,481	[2]6,413	8,957	[2]494	1,168	[2]80,737	71,654
Bagdad	17,919	20,178	5,457	7,320	4,403	8,258	78,853	82,862
Inspiration	429	W	13,567	NA	12,862	NA	51,021	W
Mission Complex	2,663	[3]6,315	1,686	[3]8,619	--	--	19,285	[3]38,322
Eisenhower	3,559	([3])	3,570	([3])	--	([3])	16,738	([3])
Pima	1,410	([3])	1,198	([3])	--	([3])	12,678	([3])
San Manuel	6,103	6,749	10,343	10,448	6,103	6,165	9,945	23,573
San Xavier	1,374	947	763	797	--	--	7,196	4,492
Miami	--	W	--	NA	--	NA	3,451	W
Silver Bell	--	--	--	--	--	--	3,244	4,954
Johnson	--	--	--	--	--	--	2,211	--
Esperanza	([2])	--	([2])	--	([2])	--	([2])	--
Mineral Park	--	--	--	--	--	--	--	2,101
UNDERGROUND								
San Manuel	16,332	16,352	791	--	--	--	92,126	86,616
Cyprus Casa Grande[4]	--	--	--	--	--	--	3,221	1,045

NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Gross metal content.
[2]In 1986, owing to change of ownership, Sierrita and Esperanza have been combined to form one unit. All future reporting will reflect this change.
[3]In 1987, owing to a company change in reporting, Mission, Eisenhower, and Pima have been combined to form one unit. All future reporting will reflect this change.
[4]Formerly Lakeshore.

Phelps Dodge Corp., the largest producer of copper in Arizona and in the United States, moved its corporate headquarters from New York City and consolidated much of its executive staff in Phoenix. Cyprus Minerals Co. continued to increase its share of copper production in the State by purchasing the Lakeshore Mine (Pinal County) from Noranda Mines Ltd. and renaming the operation Cyprus Casa Grande. The rapidly expanding firm also established a development unit for metal business near Tucson. This unit is charged with identifying and bringing into production new mining ventures in the Southwestern States and in Mexico. Negotiations to acquire the idle Twin Buttes Mine in Pima County from Park Corp. were begun toward yearend. Magma Copper Co., the second-largest copper producer in Arizona, became independent during the year when it was released by its parent, Newmont Mining Corp. ASARCO Incorporated continued to consolidate its holding adjacent to the Mission Mine (Pima County) by acquiring the interest held by the Anamax Mining Co. in the Palo Verde (Eisenhower) Mine.

Having recognized the trend to fewer suppliers of smelter feed, Asarco continued to increase its self-reliance by initiating a $13 million expansion at the Mission Complex. Most of this expansion was to be brought about through modernization of the concentrator. When completed, it will increase production capacity by 46%. Expansion and modernization of Magma's San Manuel facility continued through 1987. The processing capacity of the solvent extraction-electrowinning (SX-EW) plant will be increased to 65,000 short tons annually. Construction of a new oxygen flash furnace and smelter retrofit proceeded rapidly during the year. The capital expenditure plan, requiring $267 million, also

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included modernization of the concentrator, expansion of the refinery, and development of the deep Kalamazoo ore deposit.

Among Arizona's producers, Inspiration Consolidated Copper Co. was the only one to employ solvent extraction for a full year to recover its entire output of copper. Toward the end of the year, the company announced plans to expend $25 million to increase SX-EW capacity by 25%. Phelps Dodge also confirmed acceptance of this low-cost means of production by completing construction of a new $92 million SX-EW facility at Morenci. This facility consists of three solvent extraction units that supply one tankhouse at the rate of 30,000 gallons per minute. The complex, the largest of its type in the United States, is designed to produce 50,000 short tons of cathode copper annually.

Interest in copper deposits that may be amenable to treatment by solvent extraction continued to increase during the year. These deposits are relatively abundant in Arizona and a number of them were investigated. Phelps Dodge estimated its Cochise deposit near Bisbee to contain about 170 million tons averaging 0.5% copper. The company initiated studies to determine if this copper mineralization could be mined economically. The Kocide Chemical Co. continued development, at a reduced rate, of the VanDyke Mine in Gila County. Plans call for this chiefly oxide copper deposit to be solution-mined initially at a rate of 600,000 pounds per month of copper. Cement copper produced at the mine site will be converted to copper sulfate for agricultural fertilizers.

Gold.—Between the advent of World War II and the mid-1980's, the bulk of gold production in Arizona was a byproduct of copper mining. In 1987, primary ores of gold became an important source of this important metal.

The most significant new mine brought into production during the year was the Copperstone Mine in La Paz County. Development of this open pit property by Cyprus Copperstone Gold Corp. required about $14 million in capital expenditures; designed capacity is about 60,000 troy ounces per year.

There were several smaller surface mines operating in the State that produced gold in 1987.[4] J. Devins Resources continued its operation at the U.S. Mine in Maricopa County with gold recovered from ore heaps by cyanide leaching. Heap leaching was also used at the Portland Mine in Mohave County. Although mining operations at the Portland Mine were terminated in June, Western States Minerals Corp. continued leaching through yearend, reportedly producing about 300 troy ounces of gold per month.

Important underground gold mines in Yavapai County included the Gladiator-War Eagle Mine operated by Nor-Quest Arizona Inc., the Congress Mine under development by Echo Bay Mines, and the McCabe Mine being developed by the Stan West Mining Corp. The Nor-Quest ores were milled at a rate of approximately 100 tons per day and the gold concentrates shipped to the Cominco Ltd. smelter in British Columbia. Echo Bay completed a 3,300-foot decline ramp to development ore having a high silica content and reportedly averaging 0.3 troy ounce of gold per short ton. The ore to serve as a flux was to be shipped to the Phelps Dodge smelter at Playas, NM. Stan West Mining continued to develop its gold-bearing, multimetal McCabe Mine in Yavapai County. This relatively deep mine was being prepared to supply a concentrator, also under construction, with a daily feed of 500 short tons.

Placer gold was produced intermittently at several localities. The principal operations were in the counties of Maricopa, Pima, and Yavapai. Tailings shipped as copper-smelter flux also provided minor gold production to the State total.

Although western Arizona received the most intense exploration for gold, extensive investigation and development occurred throughout much of the State. Among the particularly active lode sites were the Gold Bug, Pilgrim, and Van Deeman Mines in Mohave County; the United Verde Extension and Vulture Mines in Yavapai County; the Mystic Mine in Maricopa County; the Gold Prince Mine in Cochise County; and the Margarita Mine in Santa Cruz County.

Molybdenum.—During 1987, the third-largest producer of molybdenum in the Nation was Arizona. All of the metal is recovered as a coproduct or byproduct of copper production.

Despite the relatively minor change in copper production during 1987, compared with that of 1986, the amount of molybdenum recovered during this year decreased over 50%. Of the five mines producing molybdenum in the State, the Cyprus Sierrita operation was the largest.

Silver.—Production of silver in Arizona declined almost 19% from the total of last year. Most of this reduction occurred in the

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Pima mining district southwest of Tucson. Because of a higher, average annual price, however, the total value of the State's silver production increased.

In Arizona, the recovery of silver is generally dependent on the production of copper since it is chiefly a byproduct of copper refining. In addition to important amounts of silver recovered from mill tailings that are fed by several properties to copper smelters, substantial silver is reported from the silica-flux ore mined underground at the Ash Peak Mine in Greenlee County. This mine produced material averaging from 5 to 6 troy ounces of silver per short ton at a rate of about 200 short tons per day. The Reymert Mine of Pinal County produced similar-grade fluxing ore at a rate of about 1,000 short tons per week. Tailings produced by a recent operator at the Contention Mine of Cochise County were washed to recover residual coproducts of silver and gold. Capacity of the plant was about 40 to 60 short tons per hour.

Other Metals.—The Sierrita Mine in Pima County was the only domestic producer of rhenium in 1987. The metal, occurring as a trace element in molybdenite, is recovered as ammonium perrhenate by roasting the molybdenum concentrates. The relatively small, but high-grade, deposits of uranium in northern Arizona were the source of about 40% of U.S. production during the year. Five mines, located in Coconino and Mohave Counties, were either in production or under development by Energy Fuels Nuclear Inc. With the exception of trace metals recovered at copper refineries, there was no recorded production of other metals in the State.

INDUSTRIAL MINERALS

Cement.—In 1987, cement production represented a significant percentage of the State's total nonfuel mineral value. This production ranks it close to the top third of all the States. Of the two Arizona producers, the largest annual capacity (1,100,000 short tons) is held by Arizona Portland Cement Co. During the year, the Phoenix Cement Co., a division of Gifford-Hill & Co., was sold to the Salt River Pima-Maricopa Indian Community.

Clays.—In terms of total value, clay mining contributes a relatively small amount to the nonfuel mineral production of Arizona. The industry, however, has grown significantly. Mine production increased about 9% during 1987, with an impressive value increase of over 39%. Enhancing the value is the production of high-quality specialty clays such as swelling and nonswelling bentonite mined in central and northeastern Arizona. The most recently developed bentonite property, the Burro Creek Mine (Yavapai County), began operation in 1987. It shipped a small tonnage of saponite, a magnesium-bearing bentonite, to be used as a viscosifier in paint.

Gem Stones.—Arizona ranked third nationally in the production of gem stones. In addition to its well-known agate, malachite, peridot, petrified wood, and turquoise, the State also produces an unusual blue, fire opal from Santa Cruz County. Arizona's share of national gem stone production was 14% in 1987, a notable decrease from that of 1986.

Lime.—Production of lime in the State increased by about 8% compared with that of 1986. Domestically, Arizona ranks 11th in total production. The State's two limestone quarries and lime plants are owned by Chemstar Inc. Total production capacity is approximately 2,800 tons per day. During 1987, the Nelson plant in Mohave County was equipped with a facility to hydrate lime. Hydrated lime, in competition with cement, is used increasingly as an additive in asphalt pavements to slow aging characteristics and to reduce moisture damage.

Perlite.—There was a sharp increase in perlite production during the year. Two mining firms operated surface pits in eastern Pinal County and supplied a variety of markets out of State. Although Arizona ranked second after New Mexico, its production is relatively small.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains actual data for 1986 and estimates for 1985 and 1987. Data for odd-numbered years are based on annual company estimates.

Arizona ranked among the top five producers of sand and gravel in the United States. Although estimates indicate a decline in production from that of 1986 of almost 6%, the sand and gravel industry was valued at $141.3 million in 1987. Most production is concentrated in the urban areas of Phoenix and Tucson. Increasing demand, however, occurs in growing areas such as Casa Grande and Sierra Vista.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered

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years only. This chapter contains actual data for 1985 and 1987 and an estimate for 1986. Data for even-numbered years are based on annual company estimates.

During 1987, production of crushed stone in Arizona increased more than 37% over estimated production in 1986. This production was valued at almost $34 million. There were 27 privately operated stone quarries and 25 controlled by Government entities. Five firms accounted for over 80% of the private production.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 5 presents end-use data for crushed stone produced in the three Arizona districts depicted in figure 1.

Table 4.—Arizona: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Filter stone	W	1,178
Coarse aggregate, graded: Concrete aggregate, coarse	359	679
Fine aggregate (-3/8 inch); Screening, undesignated	81	241
Coarse and fine aggregates:		
Graded road base or subbase	376	1,078
Unpaved road surfacing	368	1,937
Terrazzo and exposed aggregate	387	1,462
Other construction[2]	1,993	11,015
Chemical and metallurgical:		
Cement manufacture	2,116	7,819
Flux stone	(3)	120
Special: Other unspecified[4]	1,655	8,391
Total[5]	7,712	33,999

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes limestone, dolomite, marble, granite, sandstone, and volcanic cinder and scoria.
[2]Includes riprap and jetty stone, bituminous aggregate (coarse), stone sand (concrete), stone sand (bituminous mix or seal), combined coarse and fine aggregates, and crusher run or fill or waste and data indicated by symbol W.
[3]Withheld to avoid disclosing company proprietary data; included with "Special: Other unspecified."
[4]Includes roofing granules, production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

Table 5.—Arizona: Crushed stone[1] sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[2]	--	--	W	W	W	W
Coarse aggregate, graded[3]	(4)	(4)	W	W	W	W
Fine aggregate (-3/8 inch)[5]	--	--	35	60	127	699
Coarse and fine aggregates[6]	--	--	254	1,863	1,024	3,785
Other construction	--	--	25	107	2,122	10,570
Chemical and metallurgical[7]	(4)	(4)	30	120	(8)	(8)
Special[9]	--	--	--	--	(8)	(8)
Other miscellaneous	--	--	--	--	1,297	4,290
Other unspecified[10]	1,771	6,822	179	696	837	4,947
Total	1,771	6,822	523	2,846	5,407	[11]24,290

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Excludes 10,950 short tons, valued at $42,000 not reported by county.
[2]Includes riprap and jetty stone and filter stone.
[3]Includes concrete aggregate (coarse) and bituminous aggregate (coarse).
[4]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[5]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[6]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[7]Includes cement manufacture and flux stone.
[8]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[9]Includes roofing granules.
[10]Includes production reported with a breakdown by end use and estimates for nonrespondents.
[11]Data do not add to total shown because of independent rounding.

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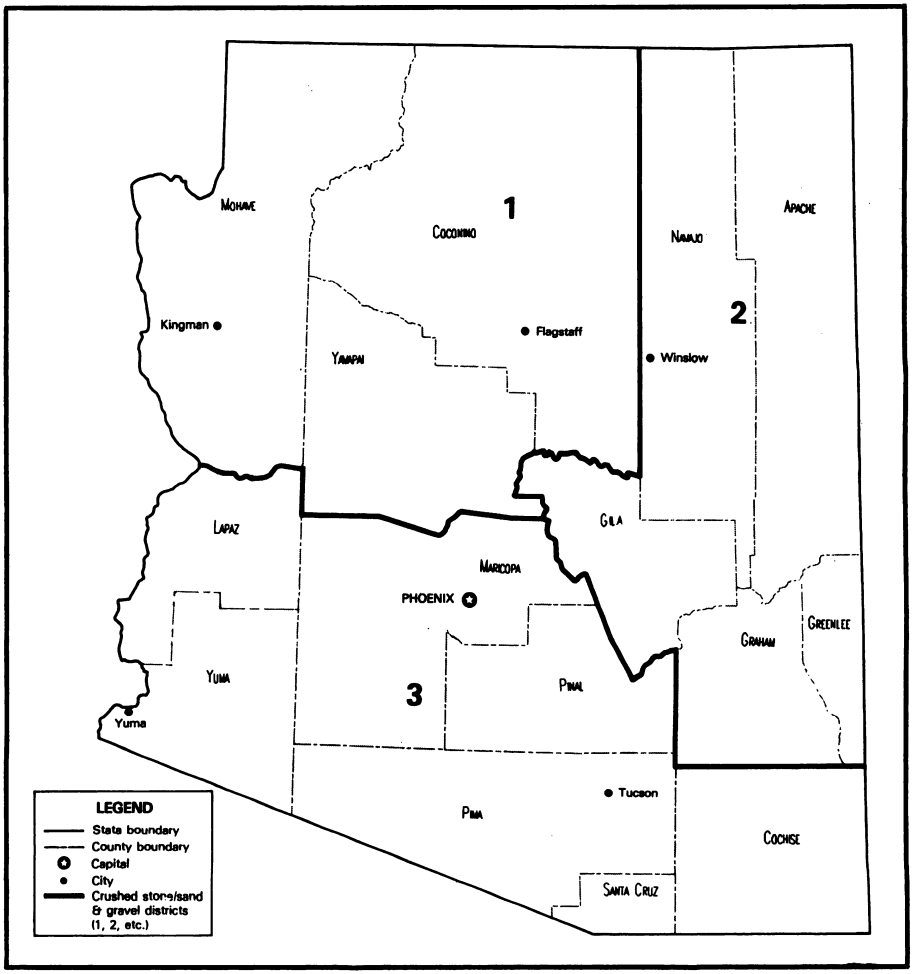

Figure 1.—Aggregate-producing districts in Arizona.

Other Industrial Minerals.—Although the combined value of a number of other commodities produced in Arizona is less than 1% of the total, the commodities are important to the citizens and the economy of the State. These industrial mineral products include diatomaceous earth, gypsum, pumice, pyrites, salt, industrial sand, dimension stone, sulfuric acid, and zeolites.

Diatomite was mined and processed at the Whitecliffs Mine in Pinal County. Production for industrial filler markets began in 1986; plant capacity is rated at 75 short tons per day.

The gypsum industry in Arizona, supporting three mining companies, produced for a variety of agricultural and manufacturing uses. Pumice, produced in Coconino, Gila, and Yavapai Counties, was used in lightweight masonry, textile abrasives, and pet waste absorbent. Pyrite concentrates were obtained from the Magma Mine in Pinal County and sold to pigment markets.

Salt was solution-mined from the Luke deposit in Maricopa County. The salt is marketed principally to agricultural and industrial users. After the salt is removed, the underground solution cavities are used to store butane and propane.

Continued production of well-rounded and well-sorted quartz sand (industrial sand) occurred at the Houck Mine in Apache County. This relatively high-value commodity has been used chiefly for hydraulic fracturing applications.

Sulfuric acid, as a byproduct of metal smelters and roasters in the United States, was produced in greatest quantity at Arizona's copper smelters. The total, 1,199,701 short tons, produced in this manner represented over 35% of the Nation's byproduct sulfuric acid.

W. R. Grace and Co. produced exfoliated vermiculite at its plant in Maricopa County. The crude vermiculite was shipped into the processing facility from out of the State,

and the final product was used primarily in fireproofing, insulation, and aggregate applications.

Two relatively small industrial mineral industries in Arizona that may eventually become larger are the production and marketing of dimension stone and zeolites. The State has large reserves of both and the diversity of dimension stone is impressive. Approximately six companies quarry dimension stone and supply various users nationwide. Similarly, as technology develops new markets for the zeolite group of minerals, the Bowie chabazite deposit (and others like it) will increase its production. In 1987, four mining firms shipped from this deposit, which straddles the Cochise-Graham County line.

[1]State Mineral Officer, Bureau of Mines, Tucson, AZ.

[2]Beard, R. R. The Primary Copper Industry of Arizona in 1987. Arizona Dep. Mines and Miner. Resour. (Phoenix), Feb. 1989, 75 pp.

[3]Leaming, G. F. The Copper Industry's Impact on the Arizona Economy 1987. West. Econ. Anal. Cent. (Marana, AZ), June 1988, 32 pp.

[4]Mine files of the Arizona Department of Mines and Mineral Resources (Phoenix).

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Arizona Portland Cement Co., a division of California Portland Cement Co., a subsidiary of CalMat Co.[1 2]	Box 338 Rillito, AZ 85654	Quarry and dry-process, 4-rotary-kiln plant.	Pima.
Salt River Pima-Maricopa Community (formerly Phoenix Cement Co.[1 2]	Box 428 Clarkdale, AZ 86324	Quarry and dry-process, 3-rotary-kiln plant.	Yavapai.
Cinder (volcanic):			
Flagstaff Cinder Sales Inc	Old Highway 66 Box 2796 Flagstaff, AZ 86003	Quarry	Coconino.
Superlite Builders Supply, a subsidiary of U.S. Industries Inc.	Box 40159 Flagstaff, AZ 86004	Open pit mine and crushing plant.	Do.
Clays:			
Building Products Co	4850 West Buckeye Rd. Phoenix, AZ 85043	Open pit mines	Navajo and Yavapai.
Clinton-Campbell Contracting Inc. (formerly Phoenix Brick Yard)	1814 South 7th Ave. Phoenix, AZ 85007	____do	Maricopa and Pima.
Harshaw/Filtrol Partnership of Kaiser Aluminum & Chemical Corp. and Chevron Corp.	Box 155 Sanders, AZ 86512	Surface strip mine	Apache.
McKusick Mosaic Co	Route 1, Box 35-D Globe, AZ 85501	Surface mine	Gila.
United Dessicants, a division of United Catalyst Inc.	Box 32370 Louisville, KY 40232	Surface strip mine	Apache.
Copper:			
ASARCO Incorporated:			
Hayden Unit	Box 98 Hayden, AZ 85235	Smelter and acid plant	Gila.
Mission Complex[3 4 5]	Box 111 Sahuarita, AZ 85629	Open pit mines and mill	Pima.
Ray Unit[3 5 6]	Box 9 Hayden, AZ 85235	Open pit mine, leach dumps, precipitation, solvent extraction-electrowinning plants.	Gila and Pinal.
Silver Bell Unit	Marana, AZ 85653	Leach dumps and precipitation plant.	Pima.
Cyprus Metals Co., a division of Cyprus Minerals Co.:			
Cyprus Bagdad Copper Co.[5 6]	Box 245 Bagdad, AZ 86321	Open pit mine, mill, dump leach, solvent extraction-electrowinning plant.	Yavapai.
Cyprus Casa Grande	Box C-9 Casa Grande, AZ 85222	In situ mine and solvent extraction-electrowinning plant.	Pinal.
Cyprus Mineral Park	Box 6249 Kingman, AZ 86401	Dump leach and precipitation plant.	Mohave.
Cyprus Sierrita Corp.[3 5 6]	Box 527 Green Valley, AZ 85622	Open pit mine, mill, leach dumps, precipitation plant, solvent extraction-electrowinning plant.	Pima.
Inspiration Consolidated Copper Co.	Box 1559 Claypool, AZ 85532	Open pit mines, mill, dump leaching, precipitation and solvent extraction-electrowinning plants, smelter, sulfuric acid plant, refinery, continuous-cast rod plant.	Gila.

See footnotes at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Copper —Continued			
Magma Copper Co.:			
San Manuel Div.[1 3 5 6 7]	Box M San Manuel, AZ 85631	Underground mine, mill, in situ and heap leaching, solvent extraction-electrowinning, acid plant, smelter, refinery, continuous cast copper rod plant.	Pinal.
Pinto Valley Div	Box 100 Miami, AZ 85539	Open pit mine, mill, leach dumps, in situ leach, solvent extraction-electrowinning plant.	Gila.
Phelps Dodge Corp.:			
Corporate Headquarters	2600 North Central Ave. Phoenix, AZ 85004-3015		
Copper Queen Branch	Highway 92 Bisbee, AZ 85603	Leach dumps, in-place leaching, precipitation plant.	Cochise.
Morenci Branch[3 5 6]	Morenci, AZ 85540	Open pit mine, mills, dump leach, precipitation and electrowinning plants.	Greenlee.
Diatomite:			
Whitecliffs Industries	460 West Roger Rd. Suite 101 Tucson, AZ 857055	Surface mine and plant	Pinal.
Gold:			
Cyprus Copperstone Gold Corp	Box A1 Parker, AZ 85344	Open pit mine, agitation leach.	La Paz.
Nor-Quest Arizona Inc	Box 416 Crown King, AZ 86343	Underground mine and concentrator.	Yavapai.
Gypsum:			
National Gypsum Co.:			
Gold Bond Building Products Div.	Box 20863 Phoenix, AZ 85036	Plant	Maricopa.
Winkelman Gypsum Pit	Star Route, Box 3990 Winkelman, AZ 85292	Open pit mine and crushing plant.	Pinal.
Pinal Gypsum Co	Box 99 Coolidge, AZ 85228	Open pit mine	Do.
Superior Companies[1 2]	1700 North 7th St., No. 5 Phoenix, AZ 85005	Quarries and plant	Apache, Pinal, Yavapai.
Lime:			
Can-Am Corp., Paul Lime Div., a subsidiary of Chemstar Inc.[2]	Drawer T Douglas, AZ 85607	Quarry and 3 lime kilns	Cochise.
Chemstar Inc	Box 197 Peach Springs, AZ 86434	Quarries and plant	Yavapai.
Perlite:			
Harborlite Inc	Box 960 Superior, AZ 85273	Open pit mine and plant	Pinal.
Nord-Sil-Flo Inc., a subsidiary of Nord Resources Corp.	Box 127 Superior, AZ 85273	____do	Do.
Pumice:			
Arizona Tufflite Inc	2432 West Peoria Phoenix, AZ 85029	Open pit mine	Coconino.
Gila Valley Block Co	Box 465 Safford, AZ 85546	____do	Graham.
Salt:			
Morton Salt Div., a subsidiary of Morton Thiokol Inc.	13000 West Glendale Ave. Glendale, AZ 85307-2408	Solution mining and solar evaporation.	Maricopa.
Sand and gravel:			
Arizona Silica Sand Co	Box 108 Houck, AZ 86506	Open pit mine	Apache.
Baseline Materials Inc	38353 Schneph Rd. Queen Creek, AZ 85242	Pits	Maricopa.
Blue Circle West Inc	2625 South 19th Ave. Phoenix, AZ 85009	____do	Do.
CalMat Co. of Arizona, a subsidiary of California Portland Cement Co., a subsidiary of CalMat Co.	1801 East University Dr. Box 52012 Phoenix, AZ 85036	Pits and plants	Do.
Century Materials	2156 East 1st St. Box 3175 Tempe, AZ 85281	Pits	Do.
Granite Construction Co	4115 East Illinois Box 27557 Tucson, AZ 85726	Pits and plants	Pima.
Mesa Materials Inc	3410 North Higley Rd. Mesa, AZ 85205	Pits	Maricopa.
Phoenix Redi-Mix Co	3635 South 43d Ave. Phoenix, AZ 85009	____do	Do.
Salt River Sand & Rock	Box 728 Mesa, AZ 85211	____do	Do.

See footnotes at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Tanner Companies	3640 South 19th Ave. Box 52124 Phoenix, AZ 85072	Pits and plants	Coconino, La Paz, Maricopa, Pima, Pinal, Yavapai, Yuma.
Union Rock & Materials Corp	2800 South Central Ave. Box 8007 Phoenix, AZ 85066	do	Maricopa and Pima.
Stone:			
Crushed:			
Andrada Marble Co	4901 East Drexel Rd. Tucson, AZ 85706	Quarry	Pima.
Arizona Granite	7401 West Villa Rita Dr. Peoria, AZ 85345	do	Maricopa.
Madison Granite Supplies	7050 Grand Ave. Glendale, AZ 85301	Quarry and plant	Do.
Red Mountain Mining Inc	4250 North Bush Hwy. Mesa, AZ 85205	do	Do.
Scala Granite	East Canyon Dr. Apache Junction, AZ 85220	do	Pinal.
Dimension:			
Dunbar Stone Co	Box 246 Ash Fork, AZ 86320	Quarries and plant	Coconino, Maricopa, Mohave, Yavapai.
Western States Stone Co	2830 Grand Ave Phoenix, AZ 85017	do	Coconino, La Paz, Maricopa, Mohave, Yavapai.
Smelter flux:			
Little Hill Mines Inc	Box 332 Oracle, AZ 85623	Open pit mine	Pinal.
Triple Nichol Inc	R.R. 1, Box N123 Globe, AZ 85501	Surface and underground mines	Gila and Pinal.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	4220 West Glenrosa Phoenix, AZ 85019	Plant	Maricopa.
Zeolite:			
GSA Resources	Box 16509 Cortaro, AZ 85652	Surface strip mine	Cochise.
Union Carbide Corp	Box 1029 Grand Junction, CO 81502	do	Do.

[1]Also clays.
[2]Also limestone.
[3]Also gold.
[4]Also lead.
[5]Also silver.
[6]Also molybdenum.
[7]Also lime.

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The Mineral Industry of Arkansas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Arkansas Geological Commission for collecting information on all nonfuel minerals.

By James R. Boyle[1] and William V. Bush[2]

The value of nonfuel mineral production in Arkansas in 1987 was $264.2 million, a slight increase over that of 1986. Leading industrial minerals in terms of value were bromine, cement, crushed stone, and sand and gravel. The State ranked first nationally in production of bauxite and bromine; second in crushed sandstone and special silica stone for abrasive products (oilstones and whetstones); and third in kaolin and tripoli.

Trends and Developments.—The economy picked up, to a degree, as the unemployment rate dropped from 9.6% in January to 8.0% at yearend. In October, total employment reached 1,041,200, the highest for any given month on record. However, the mining sectors, with the exception of primary metals, had less employment than in 1986. Primary metals employment was up over 5% while mining was down nearly 4%. Construction, a major user of nonfuel minerals, was down about 3% and stone, clay, and glass production was down 4%.

Table 1.—Nonfuel mineral production in Arkansas[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	1,052	$10,769	[2]974	[2]$8,998	908	$8,651
Gem stones	NA	[e]200	NA	522	NA	1,800
Sand and gravel:						
Construction thousand short tons	[e]8,500	[e]24,400	8,571	26,999	[e]7,200	[e]23,900
Industrial do.	412	5,414	400	3,975	505	5,147
Stone:						
Crushed do.	14,815	60,874	[e]15,500	[e]58,500	15,234	63,847
Dimension do.	5	305	[e]5	[e]305	11	629
Combined value of abrasives,[3] bauxite, bromine, cement, clays (fire clay, 1986), gypsum, lime, talc, tripoli (1986-87), vanadium (1985)	XX	168,290	XX	[r]163,703	XX	160,188
Total	XX	270,252	XX	[r]263,002	XX	264,162

[e]Estimated. [r]Revised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipment, sale, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

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Table 2.—Nonfuel minerals produced in Arkansas in 1986, by county[1]

County	Minerals produced in order of value
Bradley	Sand and gravel.
Calhoun	Do.
Carroll	Do.
Clark	Sand and gravel, clays.
Clay	Sand and gravel.
Craighead	Sand and gravel, clays.
Crawford	Sand and gravel.
Crittenden	Clays.
Cross	Sand and gravel.
Drew	Do.
Faulkner	Do.
Franklin	Do.
Fulton	Do.
Garland	Sand and gravel, abrasives.
Grant	Sand and gravel.
Greene	Do.
Hempstead	Sand and gravel, clays.
Hot Spring	Clays, sand and gravel.
Howard	Cement, gypsum.
Independence	Lime, sand and gravel.
Izard	Sand and gravel.
Jefferson	Do.
Johnson	Clays.
Lincoln	Sand and gravel.
Little River	Cement, sand and gravel.
Marion	Sand and gravel.
Miller	Sand and gravel, clays.
Montgomery	Do.
Nevada	Sand and gravel.
Ouachita	Sand and gravel, clays.
Pike	Gypsum, sand and gravel.
Poinsett	Sand and gravel.
Pope	Do.
Pulaski	Clays, sand and gravel.
St. Francis	Sand and gravel.
Saline	Bauxite, sand and gravel, talc.
Sebastian	Sand and gravel, clays.
Sevier	Sand and gravel.
Stone	Do.
Yell	Do.
Undistributed[2]	Bromine, stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—The Arkansas Legislature meets biennially and convened in 1987. The Governor signed eight acts of interest to the minerals industry. Legislation enacted included the following acts. Act 35 dedicated money in the Abandoned Mine Proceeds Fund to counties for use in the establishment of solid-waste disposal facilities. Act 48 gave benefits to new steel mills that invest at least $120 million in facilities, and also included certain tax credits and exemptions. Act 362 provided that any proceeds from mineral rights unclaimed for more than 7 years revert to the State. Act 553 required all electric utilities in the State using coal to burn a minimum amount of Arkansas-mined coal. Act 575 exempted certain taxes on utilities purchased by Quanex MacSteel, SMI Division of the Commercial Metals Corp., and Razorback Steel. Act 664 amended certain sections of the 1977 Land Reclamation Act and required that land permitted under the Act include all surface-mining operations, and also increased permit fees. Act 701 created a State Board of Registration for professional geologists. And Act 793 created a Diamond Mining Advisory Task Force to study feasibility of commercial mining at the Crater of Diamonds State Park.

In 1987, the Arkansas Department of Revenue received $12.0 million in severance taxes, down from $12.7 million in 1986. Severance taxes were received from oil ($10.4 million), sulfur ($618,000), natural gas ($433,200), brine ($494,000), coal ($2,300), and miscellaneous minerals including bauxite, diamonds, fuller's earth, and dimension stone.

The Arkansas Department of Labor, in its annual report, stated that 268 nonfuel mineral mines operated in the State and produced a total of 21.5 million short tons of minerals. This compares to 20.3 million tons in 1986. Additionally, 10 coal mines in Franklin, Johnson, Scott, and Sebastian Counties produced nearly 175,000 tons of coal during the year.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Industrial minerals constituted the major portion of the value of nonfuel mineral values in 1987.

Abrasives (Natural).—Arkansas was the second-leading State in production of silica stone abrasives in the Nation. Finished stone production accounted for nearly two-thirds of the total quantity of special stone products sold or used. Novaculite, a dense, hard, fine-grained chert of nearly pure silica, was mined in Garland County by four companies and in Hot Spring County by one company. All operations produced relatively small tonnages with a high percentage of waste material. Eight companies finished materials mined by others.

Bromine.—Arkansas remained the predominant producer of bromine in the Nation. Production increased nearly 5% over that of 1986, while value increased 12%. Bromine occurred in deep well brine in the south-central part of the State in Columbia and Union Counties. Dow Chemical U.S.A. and Ethyl Corp. operated in Columbia County while Arkansas Chemicals Inc. and Great Lakes Chemical Corp. operated in Union County. Early in the year, Ethyl completed its purchase of the majority assets of Dow's bromine and bromine derivative chemicals business for about $50 million. Included were Dow's bromine chemicals plant in Magnolia and its brine field leases in Arkansas, along with the distribution equipment and certain patents relating to bromine chemicals. With the purchase, Ethyl became the largest bromine producer in the Nation with about 48% of domestic capacity.

Great Lakes started construction of a $20 million facility to produce fluorine-based specialty chemicals at El Dorado. Completion was scheduled for mid-1988. Great Lakes will utilize technology on which its Halon fire extinguisher products are based to manufacture new products for use in aerospace, electronic, and elastomerics applications.

Cement.—Portland cement shipments decreased from those of 1986 although masonry cement output remained stable, values decreased. Two companies, Ideal Cement Co. and Arkansas Cement Corp., produced both types of cement at plants in Saratoga and Foreman, respectively. The plants used the wet process and totaled five kilns. Major uses for portland cement were ready-mixed concrete, concrete products, building materials, and highway construction. The Aluminum Co. of America (Alcoa) plant at Bauxite produced an aluminous nonportland hydraulic cement. During the year, Arkansas Cement commissioned a new firing system at its facilities in Foreman.

Clays.—The clay industry in Arkansas produced common clay and kaolin with total output decreasing from that of 1986. Production of common clay decreased while that of kaolin increased. Common clay was mined by 9 companies at 12 pits in 9 counties. Leading counties were Crittenden, Hot Spring, and Montgomery. Major uses were in brick and lightweight aggregate. Kaolin was mined by four companies at six pits in Pulaski County; output included both unprocessed and calcined kaolin. Arkansas ranked third nationally in the output of kaolin.

Gem Stones.—Park authorities at the Crater of Diamonds Park in Pike County reported that in 1987 nearly 62,000 visitors had recovered 959 diamonds compared with 930 diamonds in 1986. Total weight amounted to 160 carats; the largest diamond recovered weighed 4 carats. Of the diamonds recovered, 20 weighed over 1 carat. Recovered were 617 white diamonds, 185 brown, 145 yellow, and 12 others.

During the year, a Diamond Mining Advisory Task Force was appointed to study the feasibility of a commercial mining operation coexisting with the operation of the Crater of Diamonds Park. Before any lease could be issued, the advice of the Legislative Council must be secured. No decision is expected until 1989.

Gypsum.—Production and value of crude gypsum decreased from that of 1986. Crude gypsum was produced by Weyerhaeuser Co. in Howard County and Harrison Gypsum Co. Inc. in Pike County. Weyerhaeuser's mine and plant ranked high nationally in output. The plant had reported capacity of 600 million square feet of wallboard per year. Calcined gypsum was produced by Temple Eastex Inc., Crittenden County, and Weyerhaeuser, Howard County. Production and value increased.

Lime.—Arkansas produced both hydrated lime and quicklime during the year with

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total output decreasing and remaining at a low level. Arkansas Lime Co. produced hydrated lime and quicklime at its plant in Independence County.

Quartz.—Various grades of natural quartz were surface mined and processed by Coleman Quartz. Coleman, the only domestic producer of lascas, did not produce any in 1987. Lascas is silicon dioxide feedstock material used for production of cultured quartz, fused quartz, and other electronic uses. The quartz crystal industry experienced a substantial increase in demand during the past several years because the crystals were touted as transmitters of tranquillity and as basic good-luck rocks. Exploration increased in the Ouachita Natural Forest and adjacent lands. By yearend, between 15,000 to 25,000 acres of the forest were under permit, lease, or claim for quartz crystal. The first competitive bid for a quartz crystal lease on 80 acres had a high bid of $22,000.

Sand and Gravel.—Arkansas produced both construction and industrial sand and gravel in 1987. Total production was estimated to have decreased from that of 1986, with construction sand and gravel decreasing by over 20%.

Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the fourth leading commodity among the nonfuel minerals produced in Arkansas. The estimated decrease in 1987 was partially due to drop in construction activities. Most operations were relatively small with no individual pit producing over 1 million short tons. Leading counties in 1986 were Little River, Ouachita, and Pulaski.

Industrial.—Five companies produced industrial sand and gravel from five counties during 1987; output and value increased. Producers were Arkola Sand and Gravel Co., Gifford-Hill & Co. Inc., Ideal Cement, Malvern Minerals Co., and Silica Products Co. Inc. Major uses were in foundry molds, glassmaking and blasting abrasives; no one operation produced over 500,000 short tons.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Output of crushed stone decreased slightly, although value increased, indicating an increase in unit value. Mined material included dolomite, granite (syenite), limestone, novaculite, sandstone, and slate. Arkansas was high nationally in output of crushed sandstone and crushed slate. Arkhola Sand and Gravel was the Nation's leading producer of sandstone. Crushed stone was produced by 36 companies at 49 quarries in 28 counties. Two quarries each produced in excess of 1 million short tons in 1987, and the top five companies produced 16% of the crushed stone output. Shipments were primarily by truck with the material being used for cement manufacture, ballast, and aggregate.

Edward Bros. Co. developed its Violet Hill quarry in Izard County. The material mined was a dolomitic lime and was used for agricultural purposes.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three Arkansas districts depicted in figure 1.

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Table 3.—Arkansas: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	749	3,063
Filter stone	60	219
Coarse aggregate, graded:		
Concrete aggregate, course	561	2,446
Bituminous aggregate, coarse	710	3,077
Bituminous surface-treatment aggregate	187	1,018
Railroad ballast	331	1,359
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	121	540
Screening undesignated	315	929
Coarse and fine aggregates:		
Graded road base or subbase	2,338	8,573
Unpaved road surfacing	61	305
Crusher run or fill or waste	159	405
Other construction[2]	48	236
Agricultural: Agricultural limestone	110	483
Special:		
Other fillers or extenders	214	2,116
Other miscellaneous[3]	1,748	5,834
Other unspecified[4]	7,521	33,244
Total	[5]15,234	63,847

[1]Includes dolomite, limestone, granite, sandstone, slate, and miscellaneous stone.
[2]Includes coarse aggregate (large) and stone sand (concrete).
[3]Includes cement manufacture, lime manufacture, flux stone, chemical stone, roofing granules, and poultry grit and mineral food.
[4]Includes production reported without a breakdown by end use and estimates from nonrespondents.
[5]Data do not add to total shown because of independent rounding.

Table 4.—Arkansas: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short ton and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	319	1,191	498	2,120	--	--
Coarse aggregate, graded[2]	1,492	6,361	297	1,538	--	--
Fine aggregate (-3/8 inch)[3]	405	1,301	59	318	--	--
Coarse and fine aggregates[4]	1,923	6,807	635	2,475	--	--
Other construction	13	58	--	--	--	--
Agricultural[5]	W	W	W	W	--	--
Chemical and metallurgical[6]	W	W	W	W	--	--
Special[7]	W	W	W	W	--	--
Other miscellaneous	553	4,161	1,519	4,272	--	--
Other unspecified[8]	1,717	6,663	5,805	26,581	--	--
Total[9]	6,422	26,542	8,811	37,305	XX	XX

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous." XX Not applicable.
[1]Includes riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Includes agricultural limestone and poultry grit and mineral food.
[6]Includes cement manufacture, lime manufacture, flux stone, and chemical for alkali works.
[7]Includes other fillers or extenders and roofing granules.
[8]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[9]Data may not add to totals shown because of independent rounding.

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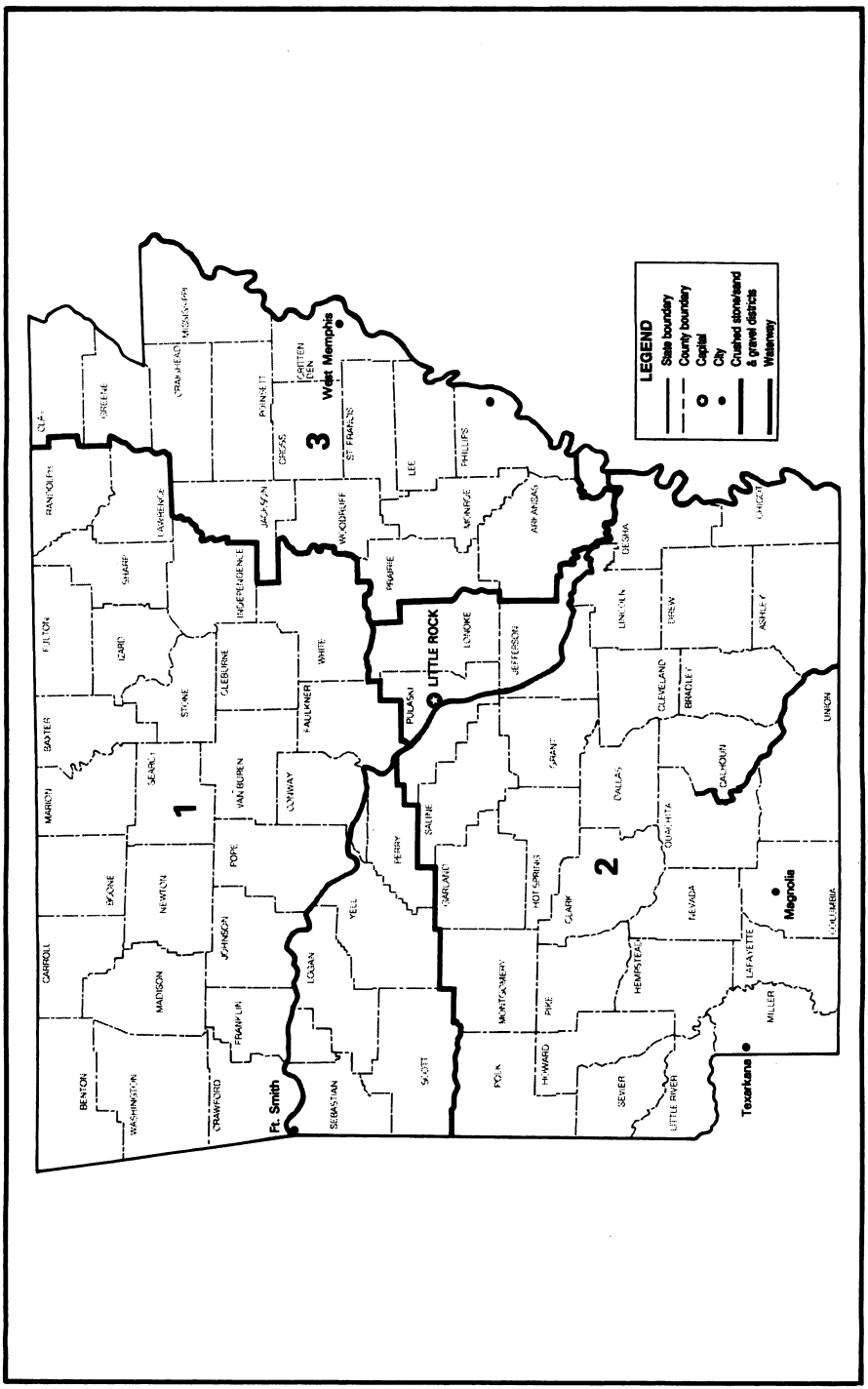

Figure 1.—Aggregate-producing districts in Arkansas.

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Dimension.—Production of dimension stone doubled compared with 1986 output. Dimension stone was quarried by three companies in Independence and Logan Counties.

Sulfur (Recovered).—Two companies reported recovery of sulfur from their operation, output remaining stable; unit prices decreased. MKP Operating Co., Lafayette County, recovered sulfur as a byproduct of petroleum refining at its McKamie plant, while Ethyl Corp. recovered sulfur during bromine extraction at its Magnolia facility.

Talc.—The Milwhite Co. Inc. mined talc near Benton from its Congo Pit and processed the ore at its Bryant mill. Production and value increased along with unit values. Major uses were as roofing materials and as an industrial filler.

Vermiculite (Exfoliated).—Strong-Lite, Pine Bluff, and W. R. Grace & Co., North Little Rock, exfoliated crude vermiculite from material mined out of State. Exfoliated vermiculite was used for texturing paint and in aggregate, insulation, agriculture, and fireproofing.

Other Industrial Minerals.—Arkansas ranked sixth nationally in output of synthetic graphite. Production of synthetic graphite remained stable although unit prices increased. Great Lakes Carbon Corp. and Superior Graphite Co. manufactured graphite electrodes at their plants in Ozark and Russellville, respectively. The raw material for the electrodes was petroleum coke, a byproduct of oil refining. The electrodes produced were used in electric arc furnaces to melt scrap for production of steel; markets were both domestic and foreign. Agrico Chemical Co., Blytheville, produced anhydrous ammonia in 1987. During the year, the facility, which has an annual capacity of 407,000 short tons, was sold to Freeport-McMoRan Inc. Perlite was expanded by Strong-Lite Products Corp. at its plant in Pine Bluff. Raw material was shipped in from out-of-State. Output and value decreased from that of 1986. Expanded perlite was used in concrete aggregate and horticultural applications. Malvern Minerals Co. Inc., Garland County, was the State's only processor of tripoli; most of the output was used as a filler. Arkansas ranked third in output of tripoli as production increased.

METALS

The primary metals sector was a relatively small part of the State's industrial base. The metals industry depended mainly on out-of-State raw materials with some output from sources in Arkansas. Developments in the iron and steel sector were being offset by reduction of activities in the aluminum industry.

Aluminum.—Arkansas was 1 of 17 States with primary aluminum production facilities. High operating costs prevented any production in 1987. Reynolds Metals Co. started installation of a $5 million triple extrusion radian cure line at its Malvern Cable Plant. Installation was scheduled for completion by mid-1988.

Red River Aluminum Inc. started construction of an aluminum-refining operation in Stamps, Lafayette County. The facility was expected to be on-line by the end of the year. Aluminum dross will be processed into aluminum ingots and shipped to rolling and shaping mills. The furnace will be fueled by natural gas piped in from a nearby gasfield.

Bauxite.—Arkansas continued to be the Nation's leading State in output of bauxite as production increased 15%. Two operations in Saline County produced bauxite: Alcoa and American Cyanamid Co. Porocel Corp. produced activated bauxite from purchased ore at its facilities in Little Rock.

Alcoa announced it would begin to phase out bauxite mining and alumina refining early in 1988. The phaseout was expected to be completed in October, resulting in the near elimination of bauxite mining in the State. Reynolds Metals Co. shut down its operations 2 years earlier. The plant's alumina chemical operation will continue, using alumina from Alcoa's facility at Point Comfort, TX. Chemicals were used for absorbents, cement, ceramics, fire and flame retardants, and plastic fillers. Alcoa reported it would retain a small mining and refining operation to supply the Norton-Alcoa plant at Fort Smith. American Cyanamid processed and partially calcined bauxite for the production of aluminum sulfate, which was used in the paper industry and for water treatment.

Gold.—Developments in the State were limited to preliminary exploration by individuals and various companies.

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Iron and Steel.—Quanex operated its specialty alloy bar plant at Fort Smith with products for the forging industry. Razorback Steel Corp. also operated a minimill at Newport that produced bars and small structural pieces. Omega Tuba & Conduit Corp. started up its second pipe mill at its plant in Little Rock. The mill, with a monthly capacity of 2,700 short tons of welded tube, produced aluminum tubing, carbon, low alloy, and stainless. The first mill was capable of producing 2,000 short tons of carbon steel pipe and tube per month. Century Tube Corp. completed a $9.5 million expansion at its Pine Bluff plant. Two new tube mills went into operation to produce tubing for chain-link fences, electrical conduit, and automotive exhaust pipes.

In August, Commercial Metals Co. started up its steel rerolling mill in Magnolia, utilizing billets. By December, the $10 million, 60,000-short-ton-per-year mill was rerolling rails. Included in the mill were a rail slitter, reheat furnace, rolling mill, and cooling bed.

Nucor-Yamato Steel Co. started construction of a $175 million, 600,000-short-ton-per-year electric furnace mill east of Blytheville adjacent to the Mississippi River. Planned startup was scheduled for mid-1988. Scrap will be shipped from the Midwest and the mill will produce I beams, flats, channels, and angles.

Vanadium.—Strategic Minerals Corp. processed petroleum residues from coal from Venezuela at its Hot Spring mill. The mill produced vanadium pentoxide and vanadium trioxide, both used to make ferrovanadium and vanadium-aluminum.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

[2]Geologist, Arkansas Geological Commission, Little Rock, AR.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
Oilstones and whetstones:			
Hiram A. Smith Whetstone Co. Inc	1500 Sleepy Valley Rd. Hot Spring, AR 71901	Quarry	Garland.
Tripoli:			
Malvern Minerals Co. Inc	Box 1246 Hot Spring, AR 71901	Mine	Do.
Bauxite:			
Aluminum Co. of America[1]	1501 Alcoa Bldg. Pittsburgh, PA 15219	Mine and plant	Saline.
American Cyanamid Co	Berdan Ave. Wayne, NJ 07470	do	Do.
Bromine:			
Arkansas Chemicals Inc	Route 6, Box 98 El Dorado, AR 71730	Brine wells and plant.	Union.
Dow Chemical U.S.A	2030 Dow Center Midland, MI 48640	do	Columbia.
Ethyl Corp., Arkansas Div	Box 729 Magnolia, AR 71753	do	Do.
Great Lakes Chemical Corp	Box 2200 West Lafayette, IN 47906	do	Union.
Cement:			
Arkansas Cement Corp., a subsidiary of Ash Grove Cement Co.[1]	Box 25900 Overland Park, KS 66225	Plant	Little River.
Ideal Cement Co., a subsidiary of Ideal Basic Industries Inc.[1]	Box 8789 Denver, CO 80201	do	Howard.
Clays:			
Acme Brick Co., a division of Justin Industries Inc.	Box 425 Fort Worth, TX 76101	Pits and plants	Hot Spring and Sebastian.
Arkansas Lightweight Aggregate Corp	El Dorado, AR 71730	Pit and plant	Crittenden.
Eureka Brick & Tile Co	Box 379 Clarksville, AR 72830	Mine	Johnson.
A. P. Green Refractories Co., a subsidiary of USG Corp.	Box 6057 Little Rock, AR 72216	Pit and plant	Pulaski.
Gypsum:			
Harrison Gypsum Co. Inc	Box 336 Lindsay, OK 73052	Mine	Pike.
Weyerhaeuser Co., Dierks Div	Route 4, Box 78 Nashville, AR 71852	Mine and plant	Howard.
Lime:			
Arkansas Lime Co., a subsidiary of Rangaire Corp.[1]	Box 2356 Batesville, AR 72501	Quarry and plant	Independence.
Perlite (expanded):			
Strong-Lite Products Corp	Box 8029 Pine Bluff, AR 71611	Plant	Jefferson.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction (1986):			
Jeffrey Sand Co	Box 998 Fort Smith, AR 72901	Pits	Faulkner, Pulaski, Sebastian.
St. Francis Materials Co., a division of Ben M. Hogan Co. Inc.	Box 999 Forrest City, AR 72335	Pits and plants	Calhoun, Craighead, Poinsett, St. Francis.
Industrial:			
Gifford-Hill & Co. Inc.[2]	Box 6615 Shreveport, LA 71136	Pits	Miller.
Silica Products Co. Inc	Box 29 Guion, AR 72540	----do	Izard.
Stone:			
Granite:			
Freshour Construction Co. Inc	Drawer AF Cabot, AR 72023	Quarry	Pulaski.
McGeorge Contracting Co. Inc	Box 7008 Pine Bluff, AR 71611	Quarries	Do.
Minnesota Mining & Manufacturing Co.	3M Center, 223-4N-05 St. Paul, MN 55144	Quarry	Do.
Limestone:			
McClinton-Anchor Co., a subsidiary of Ashland Oil Inc.	Box 756 Fayetteville, AR 72701	Quarries	Benton, Madison, Washington.
Midwest Lime Co	Box 2608 Batesville, AR 72501	Quarry	Independence.
Sandstone:			
Arkhola Sand & Gravel Co.,[1] a subsidiary of Ashland Oil Inc.	Box 1627 Fort Smith, AR 72901	Quarries	Crawford and Sebastian.
H M B Construction Co	Box 5606 Texarkana, TX 75501	Quarry	Sevier.
Ben M. Hogan Co. Inc.[1]	Box 2860 Little Rock, AR 72203	Quarries	White.
M & M Rock Co. Inc	Box 1190 Conway, AR 72032	----do	Faulkner, Perry, White.
Slate:			
Bird & Son Inc	Drawer 151 Glenwood, AR 71943	Quarry	Montgomery.
Sulfur (recovered):			
Ethyl Corp., Arkansas Div	Box 729 Magnolia, AR 71753	Sulfur recovered in bromine extraction.	Columbia.
Phillips Petroleum Co	724 Adams Bldg. Bartlesville, OK 74004	Sulfur recovered as a byproduct of petroleum refining.	Lafayette.
Talc:			
The Milwhite Co. Inc	Box 15038 Houston, TX 77020	Mine and plant	Saline.
Vanadium:			
Strategic Minerals Corp	Route 6, Box 943 Hot Spring, AR 71901	Mine and mill	Garland.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Pulaski.
Strong-Lite Products Corp	Box 8029 Pine Bluff, AR 71611	----do	Jefferson.

[1]Also produced limestone.
[2]Also produced construction sand and gravel in Ouachita County.

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The Mineral Industry of California

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the California Department of Conservation, Division of Mines and Geology, for collecting information on all nonfuel minerals.

By Fred V. Carrillo,[1] Brian E. Tucker,[2] and J. L. Burnett[3]

California produced nearly 10% of the Nation's nonfuel mineral commodities in 1987, with a value of $2.6 billion, and continued its ranking as the No. 1 nonfuel-mineral-producing State in the United States. Value increased nearly 13% above that of 1986. The increase was attributed to the generally improved economy in

Table 1.—Nonfuel mineral production in California[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Boron minerals thousand short tons	1,269	$404,775	1,251	$426,086	1,385	$475,092
Cement (portland) do.	9,462	601,506	9,490	578,502	9,937	593,859
Clays do.	[2]2,203	[2]26,600	[2]2,449	[2]33,289	2,296	33,045
Gem stones	NA	[e]550	NA	418	NA	3,367
Gold (recoverable content of ores, etc.) troy ounces	187,813	59,660	425,617	156,729	602,605	269,937
Gypsum thousand short tons	1,332	12,201	1,378	10,777	1,468	11,719
Lime do.	367	24,733	371	24,187	465	25,745
Mercury 76-pound flasks	--	--	--	--	([3])	([3])
Pumice thousand short tons	78	1,491	46	1,263	42	1,539
Sand and gravel:						
Construction do.	[e]112,800	[e]430,000	128,407	498,456	[e]141,600	[e]561,300
Industrial do.	2,255	37,434	2,364	44,813	2,241	41,472
Silver (recoverable content of ores, etc.) thousand troy ounces	115	709	155	849	122	854
Stone:						
Crushed thousand short tons	41,199	174,395	[e]38,500	[e]159,300	44,315	186,504
Dimension do.	23	2,449	[e]23	[e]2,582	33	4,554
Talc and pyrophyllite do.	100	2,493	64	1,528	W	W
Combined value of asbestos, barite (1987), calcium chloride (natural), cement (masonry), clays (ball clay, 1986, and fire clay, 1985), copper, diatomite, feldspar, iron ore (usable), magnesium compounds, molybdenum, peat, perlite, potassium salts, rare-earth metal concentrates, salt, sodium carbonate (natural), sodium sulfate (natural), tungsten ore and concentrate, wollastonite (1986-87), and value indicated by symbol W	XX	333,014	XX	330,638	XX	342,298
Total	XX	2,112,010	XX	2,269,417	XX	2,551,285

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Less than 1/2 unit.

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Table 2.—Nonfuel minerals produced in California in 1986, by county[1]

County	Minerals produced in order of value
Alameda	Sand and gravel, salt, clays.
Amador	Sand and gravel, clays.
Butte	Sand and gravel.
Calaveras	Asbestos, sand and gravel, talc, gold, clays, silver.
Colusa	Sand and gravel.
Contra Costa	Sand and gravel, lime, clays.
Del Norte	Sand and gravel, gold.
Fresno	Sand and gravel, gold, clays, silver.
Glenn	Sand and gravel, lime.
Humboldt	Sand and gravel.
Imperial	Gold, gypsum, lime, sand and gravel, silver.
Inyo	Boron minerals, tungsten, talc, clays, perlite, molybdenum, sand and gravel, pumice, gold, copper.
Kern	Boron minerals, cement, sand and gravel, clays, gypsum, gold, silver.
Kings	Gypsum.
Lake	Sand and gravel.
Lassen	Sand and gravel, diatomite.
Los Angeles	Sand and gravel, clays, lime, feldspar.
Madera	Sand and gravel, pumice.
Marin	Clays, sand and gravel.
Mariposa	Sand and gravel.
Mendocino	Do.
Merced	Do.
Modoc	Peat, sand and gravel.
Mono	Pumice, sand and gravel, clays, gold, silver, talc.
Monterey	Magnesium compounds, lime, sand and gravel.
Napa	Gold, salt, silver, sand and gravel.
Nevada	Sand and gravel, clays, gold.
Orange	Sand and gravel, feldspar, clays.
Placer	Sand and gravel, clays.
Plumas	Gold, sand and gravel.
Riverside	Cement, sand and gravel, clays, gypsum, iron ore.
Sacramento	Sand and gravel, clays.
San Benito	Asbestos, sand and gravel, clays.
San Bernardino	Cement, sodium carbonate, boron minerals, sand and gravel, rare-earth minerals, sodium sulfate, potash, calcium chloride, salt, clays, lime, gold, iron ore, talc, silver, gypsum.
San Diego	Sand and gravel, salt, feldspar.
San Joaquin	Sand and gravel, lime, gold, silver.
San Luis Obispo	Sand and gravel, gypsum.
San Mateo	Magnesium compounds, salt, sand and gravel.
Santa Barbara	Diatomite, sand and gravel, lime.
Santa Clara	Cement, sand and gravel.
Santa Cruz	Cement, sand and gravel, clays, peat.
Shasta	Cement, sand and gravel, clays, diatomite.
Sierra	Gold.
Siskiyou	Gold, silver, pumice, sand and gravel.
Solano	Sand and gravel.
Sonoma	Do.
Stanislaus	Sand and gravel, gold, clays, silver.
Sutter	Sand and gravel, clays.
Tehama	Sand and gravel.
Trinity	Do.
Tulare	Do.
Tuolumne	Lime.
Ventura	Sand and gravel, gypsum.
Yolo	Sand and gravel, lime.
Yuba	Gold, sand and gravel, clays.
Undistributed[2]	Stone (crushed), gem stones, wollastonite.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

the State, resulting in somewhat higher prices, and to a 72% increase in the value of gold production. Most industrial mineral operations continued to function near capacity with modest growth.

California was the sole U.S. producer of boron minerals. It ranked first nationally in the production of asbestos, diatomite, rare-earth concentrates, construction sand and gravel, natural sodium sulfate, and tungsten. It was second in the production of natural calcium chloride, gold, magnesium compounds from seawater, sodium carbonate, and wollastonite.

Trends and Developments.—In 1987, 37 mineral commodities, including 8 metals and 29 industrial minerals were produced within the State. Industrial minerals continued to dominate California's nonfuel mineral production, but metal production value rose to 12% of total production as rising gold output and value added to the State total.

Increased gold production of nearly 177,000 ounces over that of 1986 continued California's ranking as the second largest

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gold-producing State in the Nation. Production increases from existing mines were supplemented with output of several newly opened mines.

Asbestos production continued to decline in 1987 because of lower demand attributed to concerns about product safety. Kaiser Steel Corp. began a 42% layoff of its Oakland corporate staff in October.

Limited production was resumed in October at Strategic Minerals Corp.'s (Stratcor) tungsten operation near Bishop, but tungsten production remained at record-low levels throughout the year.

Legislation and Government Programs.—The U.S. Supreme Court ruled in March that the California Coastal Commission had the legal authority to require a mining operation in Los Padres National Forest to obtain a State permit *California Coastal Commission* vs. *Granite Rock Co.* 85-1200. The decision reversed a Federal Court of Appeals ruling that the State-permit requirement was preempted by Federal regulation.

The California State Mining and Geology Board continued work toward completion of the designation of aggregate resources in eight metropolitan areas in the State, which included the Claremont-Upland, San Bernardino, Saugus-Newhall, Palmdale, North San Francisco Bay, South San Francisco Bay, Monterey Bay, and Fresno Production-Consumption Regions. The certification of ordinances for 13 additional cities and the adoption of 6 mineral land classification reports for both urban and nonurban areas were reviewed and distributed to lead agencies.

Assembly bill 747 requiring existing surface-mining operations with vested rights and without an approved reclamation plan to submit a plan to the lead agency not later than March 31, 1988, was signed into law in September.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Asbestos.—Asbestos production continued to decline in 1987, but California remained the Nation's leading producer. Production was reported from the Calaveras Asbestos Corp. Copperopolis Mine in Calaveras County and from the KCAC Inc.'s Joe Asbestos Mine located 3 miles east of Copperopolis.

Boron.—Sales of boron minerals rose nearly 12% in value from the 1986 figure to $475 million from production of 1.385 million short tons. California was the only domestic source of boron minerals, principally in the form of sodium borate.

The majority of the boron production continued to be from Kern County, with the balance from San Bernardino County. United States Borax & Chemical Corp., a part of RTZ Borax Ltd. of the RTZ Corp. PLC of the United Kingdom, was the primary world supplier of sodium borates. U.S. Borax mined and processed crude and refined hydrated sodium borates and their anhydrous derivatives from tincal ores, and anhydrous boric acid from kernite ore reserves at Boron, Kern County.

Kerr-McGee Chemical Corp. operated the Trona and Westend plants at Searles Lake, San Bernardino County, to produce borax and boric acid products from mineral-rich lake brines. American Borate Co., a wholly owned subsidiary of Owens-Corning Fiberglas Corp., continued sales of ulexite from storage at Dunn.

Cement.—California's most valuable mineral commodity in 1987 was portland cement with a value of $594 million. California ranked first among the States in production of finished portland cement, furnishing 13% of the U.S. total. A small amount of masonry cement was also produced in the State during 1987. Eleven plants continued to report cement production, eight of which were in the southern half of the State.

The Pacific region, particularly southern California, continued to enjoy unprecedented growth in cement consumption. CalMat Co., Mitsubishi Mining and Cement Co. Ltd., Southwestern Portland Cement Co., and Gifford-Hill & Co. Inc. were among the leading California producers of finished portland cement.

Hanson Trust PLC, a British construction firm, purchased Kaiser Cement Corp., of Oakland, CA, which had plants in both northern and southern California. The Kaiser Cushenberry plant was then sold to Mitsubishi. National Cement Co., a subsidiary of Société Anonyme des Ciments Vicat of France, purchased the Lebec plant of General Portland Inc., a subsidiary of Lafarge Corp., also of France. Allied Cement Co. opened a 600,000-ton-annual-throughput terminal in the Port of Los Angeles.

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Clays.—Production of 2.455 million short tons of clay and shale valued at more than $33 million was reported in 1987 from 34 companies in 17 counties throughout the State. Common clay and shale comprised the bulk of the clays produced, with 11 companies reporting ball clay, bentonite, or kaolin deposits.

Diatomite.—California continued to lead all other States in the production of diatomite during 1987. The major producer was Manville Products Corp. from operations near Lompoc in Santa Barbara County. Grefco Inc. operated the second largest diatomite quarry in the State. Production from its quarry in the Lompoc area was supplemented with diatomite from its Burney plant in Shasta County.

Feldspar.—California ranked third nationally in the production of feldspar and feldspar-silica mixtures with quantity and value rising about 15% from that of 1986. The production of feldspar-silica mixture was reported from Crystal Silica Co.'s San Diego County plant, California Silica Products Co.'s Orange County plant, and from Calspar Inc.'s San Bernardino County plant.

Gypsum.—California ranked first nationally in the production of calcined gypsum in 1987, with total output of 1.924 million short tons, although its total output of 1.468 million short tons of crude gypsum was ranked only fifth.

The U.S. Gypsum Plaster City plant in Imperial County was California's largest producer. Crude gypsum was also mined in Kern, Kings, Riverside, San Bernardino, San Luis Obispo, and Ventura Counties. Calcined gypsum production was reported from plants in Alameda, Contra Costa, Imperial, and Los Angeles Counties. Byproduct gypsum was produced in Contra Costa and Fresno Counties.

Lime.—Lime output, following a national trend, increased 25% to 0.465 million short tons valued at more than $25 million. The National Refractories and Minerals Corp.'s Natividad quicklime plant in Monterey County was the State's largest producer. Production was reported from 11 plants in 11 different counties throughout the State.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates. California remained the leading construction sand and gravel producing State with an estimated 141.6 million short tons sold or used in 1987 with a value of $561.3 million.

ARC America Corp. of Newport Beach, a subsidiary of the Consolidated Goldfields Ltd. of the United Kingdom, acquired the California operations of American Aggregates Corp. of Greenville, OH. U.S. Silica Co., a subsidiary of Pacific Coast Resources Corp. of Los Angeles, purchased Warrior Sand Co. of Huntshore, AL.

Industrial.—Industrial sand production of 2.241 million short tons was reported from 10 operations in 9 counties. Three companies each produced more than 2 million tons. Industrial sand was used primarily in blasting, fiberglass manufacture, and glass containers.

California Silica Products Co. of Newport Beach, a subsidiary of Oglebay Norton Co., completed an expansion to its silica sand operation at San Juan Capistrano. The plant, which was designed to produce glass sand, will also supply some new markets including the construction industry.

Sodium Compounds.—California led the Nation in natural sodium sulfate production during 1987 and was second in the production of sodium carbonate. All sodium sulfate production was from Kerr-McGee Chemical Corp.'s Westend plant in San Bernardino County, where natural brines were pumped from Searles Lake. Kerr-McGee also produced sodium carbonate at its Argus and Westend plants.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

In 1985, the U.S Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three California districts in figure 1.

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Table 3.—California: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	1,250	7,581
Filter stone	289	1,328
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,830	5,241
Bituminous aggregate, coarse	2,739	13,322
Railroad ballast	133	474
Fine aggregate (-3/8 inch):		
Stone sand, concrete	619	4,146
Stone sand, bituminous mix or seal	683	2,593
Screening, undesignated	240	504
Coarse and fine aggregates:		
Graded road base or subbase	5,647	20,810
Unpaved road surfacing	188	659
Terrazzo and exposed aggregate	173	1,429
Crusher run or fill or waste	2,741	7,082
Other construction[2]	3,259	20,269
Chemical and metallurgical:		
Cement manufacture	18,254	58,018
Dead-burned dolomite manufacture	67	716
Special:		
Roofing granules	1	14
Other miscellaneous[3]	765	7,312
Other unspecified[4]	5,437	35,015
Total	44,315	[5]186,504

[1]Includes limestone, shell, traprock, sandstone, quartzite, volcanic cinder and scoria, slate, marble, and miscellaneous stone.
[2]Includes macadam, coarse aggregate (large), bituminous surface-treatment aggregate, and coarse aggregate (graded).
[3]Includes agricultural uses, lime manufacture, flux stone, asphalt fillers or extenders, other fillers or extenders, glass manufacture, and sugar refining.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown becaused of independent rounding.

Table 4.—California: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	31	213	632	3,548	1,186	7,239
Coarse aggregate, graded[2]	14	31	6,007	28,712	1,383	6,999
Fine aggregate (-3/8 inch)[3]	8	50	1,165	4,010	369	3,184
Coarse and fine aggregates[4]	91	262	6,821	23,613	1,837	6,106
Other construction	27	59	219	1,413	([5])	1
Agricultural[6]	--	--	W	W	W	W
Chemical and metallurgical[7]	([8])	([8])	W	W	14,584	49,290
Special[9]	--	--	W	W	W	W
Other miscellaneous	--	--	3,759	13,779	31	340
Other unspecified[10]	1,310	4,309	3,087	15,180	1,751	18,168
Total[11]	1,482	4,923	21,691	90,255	21,143	91,326

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, and coarse aggregate (graded).
[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[5]Less than 1/2 unit.
[6]Includes agricultural limestone, poultry grit and mineral food, and agricultural uses.
[7]Includes cement manufacture, lime manufacture, dead-burned dolomite, flux stone, and glass manufacture.
[8]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[9]Includes asphalt filler, whiting or whiting subsititute, other fillers or extenders, roofing granule, and sugar refining.
[10]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[11]Data may not add to totals shown because of independent rounding.

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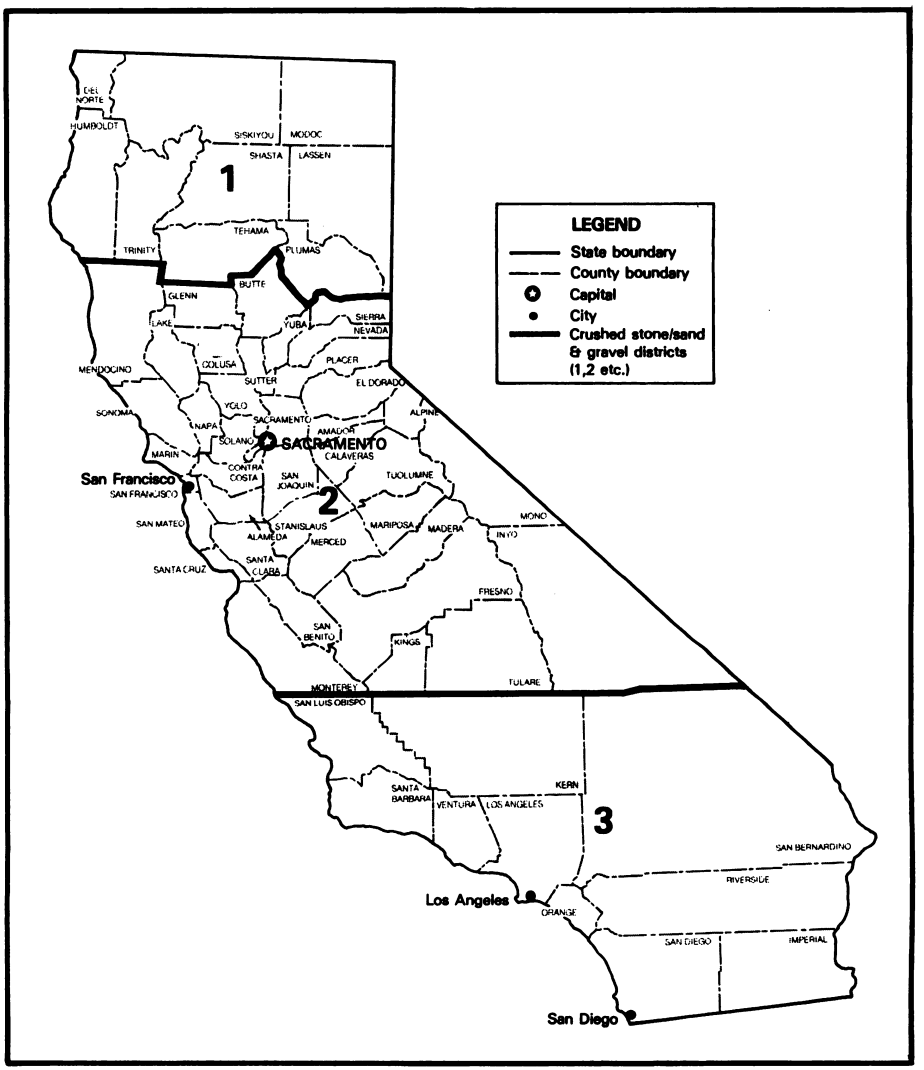

Figure 1.—Aggregate-producing districts in California.

Vermiculite (Exfoliated).—California ranked first among the 28 States that reported exfoliated vermiculite production in 1987. W. R. Grace & Co. was the sole producer from plants in Alameda and Orange Counties. Principal use was in fireproofing, with smaller amounts used in concrete and plaster aggregates and in horticulture.

Other Industrial Minerals.—Barite was produced by Robinson Enterprises Inc. in Nevada County. Natural calcium chloride production was reported from three operations in San Bernardino County. Three plants in Los Angeles County and one plant in Sacramento County produced synthetic graphite for cloth and/or fibers. Magnesium compounds were obtained from seawater

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magnesia operations in Monterey and San Mateo Counties.

Radel Inc. in Modoc County and Hyponex Corp. in Santa Cruz County were the only peat producers. Processed perlite production was reported from seven plants in Los Angeles, San Bernardino, and San Diego Counties. Kerr-McGee produced muriate of potash (60% K_2O) and sulfate of potash (50% K_2O) from plants in San Bernardino County.

California remained the third largest pumice-producing State despite a continuing slide in production to 0.042 million short tons of pumice and pumicite (volcanic ash) sold in 1987. It ranked sixth among the 9 States reporting talc and pyrophyllite production from 18 plants in 7 counties. Pfizer Inc. was the State's sole wollastonite producer from an operation in Riverside County.

Byproduct sulfur was recovered at 15 oil refineries in Contra Costa, Kern, Los Angeles, and Solano Counties.

METALS

Gold.—Exploration for gold and gold production increased significantly during the year. California again was the second largest gold-producing State in the Nation, with reported production of 0.603 million troy ounce valued at nearly $270 million. Increased production from the major gold operations in the State and a rising gold price were responsible for most of the 42% increase in quantity and 72% rise in value over that of 1986. Also adding significantly to the increased 1987 production were two new operations: CoCa Mines Inc.'s Cactus Gold Mine in Kern County and Sonora Mining Corp.'s Jamestown Mine in Tuolumne County, which was the State's third largest producer. Gold production was reported from 18 lode mines in the State and 2 placer operations in Fresno and Yuba Counties.

Gold Fields Mining Corp.'s Mesquite Mine in Imperial County became the State's largest producer in 1987, closely followed by the McLaughlin Mine of Homestake Mining Co. in Napa County. Production continued in 1987 at the Carson Hill Mine in Calaveras County, the Picacho Mine in Imperial County and the Morning Star Mine in San Bernardino County. The Colosseum Mine, the Standard Hill Mine in Kern County, and the Goldstripe Mine also began production during the year.

Rare-Earth Metal Concentrate.—Rare-earth production increased nearly 50% in quantity and more than 50% in value over that of 1986. Molycorp Inc., a wholly owned subsidiary of Unocal Corp., was the sole U.S. producer from the Mountain Pass bastnasite mine in San Bernardino County. The company began a $5 million modernization and elargement program to enhance production at its large carbonatite ore body at Mountain Pass.

Silver.—California's silver production decreased 21% from 1986 to 122,000 troy ounces. However, owing to higher silver prices, value increased $5,000 to $854,000. Silver production was recovered principally as byproduct from nine gold mines in Calaveras, Imperial, Kern, Mono, Napa, and San Bernardino Counties. Principal producers were the Carson Hill Mine in Calaveras County, the Mesquite Mine in Imperial County, the McLaughlin Mine in Napa County, and the Morning Star Mine in San Bernardino County. A small amount of placer silver was reported from gold-dredging and gravel operations in Fresno and Yuba Counties.

Tungsten Ore and Concentrate.—Tungsten production declined to the lowest level in recent years as all major producers in the State were closed during most of the year. Limited production was resumed in October at Stratcor's Pine Creek tungsten operation near Bishop.

Other Metals.—Production of crude iron ore continued to decline in the State; output was 40% less than that reported in 1986. All of California's limited 1987 molybdenum production was byproduct from tungsten recovery at Stratcor's Pine Creek Mine in Inyo County.

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[1]State Mineral Officer, Bureau of Mines, Reno, NV.
[2]Acting State geologist, California Department of Conservation, Division of Mines and Geology, Sacramento, CA.
[3]Geologist, California Department of Conservation, Division of Mines and Geology, Sacramento, CA.

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Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Calaveras Asbestos Corp	Box 127 Copperopolis, CA 95228	Surface mine and plant.	Calaveras.
KCAC Inc	Box K King City, CA 93930	____do_____	San Benito.
Boron minerals:			
Kerr-McGee Chemical Corp.[1]	Kerr-McGee Center Oklahoma City, OK 73125	Evaporators and plant.	San Bernardino.
United States Borax & Chemical Corp.	Box 75128 Sanford Station Los Angeles, CA 90010	Surface mine and plant.	Kern.
Calcium chloride:			
Leslie Salt Co.,[2] a subsidiary of Cargill Inc.	Box 5621 Minneapolis, MN 55440	Solar evaporators	San Bernardino.
National Chloride Co. of America[2]	Box 604 Norwalk, CA 90650	____do_____	Do.
Cement:			
CalMat Co.[3]	3200 San Fernando Rd. Los Angeles, CA 90065	Plants	Various.
Kaiser Cement Corp. (Mitsubishi Mining and Cement Co. Ltd.).	300 Lakeside Dr. Oakland, CA 94612	____do_____	Do.
Southwestern Portland Cement Co.[4]	Box 987 Victorville, CA 92392	Plant	San Bernardino.
Clays:			
Excel Minerals Co	Box 878 111 South La Patera Lane Goleta, CA 93116	Pits	Kern.
Gifford-Hill & Co. Inc., Phoenix Cement Co.[5]	Box 47127 Dallas, TX 75241	____do_____	Various.
Lightweight Processing Co	715 North Central Ave. Suite 321 Glendale, CA 91203	____do_____	Ventura.
Lincoln Clay Products Co	Box 367 Lincoln, CA 95648	Pit	Placer.
Lone Star Industries Inc.[5]	2800 Campus Dr. San Mateo, CA 94403	Pit	Santa Cruz.
Port Costa Materials Inc	Box 5 Port Costa, CA 94569	Pit	Contra Costa.
Diatomite:			
Grefco Inc	3425 Lomita Blvd. Torrence, CA 90509	Surface mine and plant.	Santa Barbara and Shasta.
Manville Products Corp	2500 Miguelito Rd. Lompoc, CA 93436	____do_____	Santa Barbara.
Feldspar:			
California Silica Products Co.[6]	Box 248 31302 Ortega Hwy. San Juan Capistrano, CA 92693	____do_____	Orange.
Crystal Silica Co	3231 Oceanside Dr. Oceanside, CA 92054	Mine and plant	San Diego.
Gold:			
Gold Fields Mining Corp.[7]	HCR 76 Glamis 100 Brawley, CA 92227	Surface mine	Imperial.
Homestake Mining Co.[7]	650 California St. San Francisco, CA 94108	Surface mine and plant.	Napa.
Gypsum:			
USG Corp	Plaster City, CA 92269	____do_____	Imperial.
Lime:			
Chemstar Inc.[8]	901 Mariners Island Blvd. Suite 425 San Mateo, CA 94404	____do_____	Monterey.
National Refractories & Minerals Corp.	Box 30 Moss Landing, CA 95039	____do_____	Do.
Perlite:			
American Perlite Co	11831 Vose St. North Hollywood, CA 91605	Surface mine and mill.	Los Angeles.
Pumice:			
American Pumice Products Inc	17992 Mitchell, South Irvine, CA 92714	____do_____	Inyo.
Tionesta Aggregates Co	13290 Hodge Dr. Reno, NV 89511	Surface mine	Siskiyou.
Rare earths:			
Molycorp Inc	Union Oil Center 461 South Boylston St. Los Angeles, CA 91017	____do_____	San Bernardino.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (construction):			
CalMat Co	3200 San Fernando Rd. Los Angeles, CA 90065	Pits	Various.
Koppers Co. Inc., Kaiser Sand & Gravel Co.	Box 640 Santa Monica, CA 93456	____do	Do.
Livingston-Graham	16080 East Arrow Hwy. Irwindale, CA 91706	____do	Do.
Owl Rock Products Co	Box 330 Arcadia, CA 91006	____do	Do.
Pleasanton Gravel Co	Box 850 Pleasanton, CA 94566	Pit	Alameda.
A. Teichert & Sons Inc., Teichert Aggregates.	Box 15002 Sacramento, CA 95851	Pits	Various.
Talc and pyrophyllite:			
Pfizer Inc.[9]	Box 558 Lucerne Valley, CA 92356	Surface mine and plant.	Inyo.
Western Source Inc	Box 280 San Andreas, CA 95249	Surface mine and mill.	Calaveras.
Tungsten ore and concentrate:			
U.S. Tungsten Corp., a subsidiary of Strategic Minerals Corp. (Stratcor).[10]	Route 2 Bishop, CA 93514	Underground mine and plant.	Inyo.
Vermiculite (exfoliated):			
W. R. Grace & Co	1114 Avenue of the Americas New York, NY 10036	Plants	Alameda and Orange.

[1]Also lime, potassium salts,
[2]Also salt.
[3]Also clays, gypsum, and iron ore.
[4]Also clays.
[5]Also cement and industrial sand.
[6]Also industrial sand.
[7]Also silver.
[8]Also magnesium compounds.
[9]Also clays and wollastonite.
[10]Also molybdenum.

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The Mineral Industry of Colorado

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Colorado Geological Survey for collecting information on all nonfuel minerals.

By Jane P. Ohl[1] and Mark W. Davis[2]

The value of nonfuel minerals produced in Colorado in 1987 was $373 million. This figure is slightly higher than that of 1986 but 71% lower than that of 1980, when the State's molybdenum mines were operating at peak capacity. Moderate to significant increases in output were reported for most other metals: copper, gold, lead, silver, vanadium, and zinc, and for some industrial minerals: clays, lime, pyrites, industrial sand and gravel, and crushed stone.

Nationwide, Colorado ranked 22d in value of nonfuel mineral production, compared with 23d in 1986 and 7th in 1980. Nonfuel mineral value in 1987 equaled 1.4% of the national total. Twenty-one nonfuel minerals were produced in the State: 14 industrial minerals and 7 metals. Nonfuel mineral values were divided evenly between metals and industrial minerals.

Table 1.—Nonfuel mineral production in Colorado[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	303	$1,743	242	$1,523	292	$1,763
Gem stones	NA	e$80	NA	100	NA	100
Gold (recoverable content of ores, etc.) troy ounces	43,301	13,755	120,347	44,317	178,795	80,091
Gypsum thousand short tons	233	1,800	W	W	W	W
Sand and gravel (construction) do.	e27,500	e88,000	23,233	70,095	e22,800	e84,300
Silver (recoverable content of ores, etc.) thousand troy ounces	549	3,370	645	3,526	861	6,033
Stone:						
Crushed thousand short tons	7,037	25,930	e8,000	e30,700	8,045	33,465
Dimension do.	2	204	e4	e255	3	133
Combined value of cement, copper, iron ore (usable, 1985), lead, lime, molybdenum, peat, perlite, pyrites (1985, 1987), sand and gravel (industrial), tin (1985), tungsten ore and concentrate (1985-86), vanadium, zinc, and values indicated by symbol W	XX	273,611	XX	219,492	XX	167,104
Total	XX	408,493	XX	370,008	XX	372,989

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Colorado in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel.
Alamosa	Do.
Arapahoe	Do.
Baca	Do.
Boulder	Cement, sand and gravel, clays, gold, silver, peat.
Chaffee	Lime, sand and gravel, peat.
Clear Creek	Molybdenum, sand and gravel.
Crowley	Sand and gravel.
Custer	Sand and gravel, perlite.
Delta	Sand and gravel.
Douglas	Sand and gravel, clays.
Eagle	Sand and gravel, gypsum.
Elbert	Clays, sand and gravel.
El Paso	Sand and gravel, clays.
Fremont	Cement, gypsum, sand and gravel, clays.
Garfield	Sand and gravel.
Grand	Do.
Gunnison	Sand and gravel, gold.
Huerfano	Sand and gravel.
Jackson	Do.
Jefferson	Sand and gravel, clays.
Kit Carson	Sand and gravel.
Lake	Molybdenum, zinc, gold, lead, silver, tungsten, copper, sand and gravel.
La Plata	Sand and gravel.
Larimer	Cement, sand and gravel, gypsum.
Las Animas	Sand and gravel.
Lincoln	Do.
Logan	Do.
Mesa	Do.
Moffat	Sand and gravel, gold.
Montezuma	Sand and gravel.
Montrose	Vanadium, sand and gravel.
Morgan	Sand and gravel.
Otero	Do.
Ouray	Sand and gravel, gold, silver, lead, copper.
Park	Peat.
Phillips	Sand and gravel.
Pitkin	Do.
Prowers	Do.
Pueblo	Sand and gravel, clays.
Rio Blanco	Sand and gravel.
Rio Grande	Gold, silver, sand and gravel.
Routt	Sand and gravel.
Saguache	Gold, silver.
San Juan	Gold, zinc, silver, lead, copper.
San Miguel	Sand and gravel.
Sedgwick	Do.
Summit	Do.
Teller	Gold, peat, silver, sand and gravel.
Washington	Sand and gravel.
Weld	Do.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—The very large increase in output from gold and silver mines was the most significant occurrence in the Colorado mining industry. Many mining and quarrying activities were on a downward trend, were leveling off, or were competing with urban developments for land use.

In the 1986-87 period, planning boards of counties adjacent to Denver, such as Boulder, Douglas, and Jefferson, were not approving new or expanded quarrying or mining projects. Boards were reacting to pressure from residents to eliminate quarrying and mining activities perceived as visibly or audibly offensive. Construction contractors and quarry operators had to transport heavy building materials from greater distances, driving up the costs for homeowners and for all taxpayers. Since 1980, the amount of sand and gravel mined in Clear Creek and Weld Counties has grown mainly because of increased construction and building in the distant Denver metropolitan area.

Employment.—Colorado's unemployment rate sank to a 2-year low, 6.4%, in October 1987. In Lake County, the site of one of the State's largest mines, the unemployment rate remained high (22%), owing principally to greatly reduced activity at AMAX Inc.'s Climax molybdenum mine.

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The Colorado Division of Mines estimated that more than 2,000 workers were employed in the nonfuel mining sector during 1987. Of these, 63% worked at the following mines: 440 at AMAX's Henderson Mine and mill; 320, Echo Bay Mines Inc.'s Sunnyside Mine; 240, Galactic Resources Inc.'s Summitville Mine; 137, ASARCO Incorporated's Black Cloud Mine; 65, Camp Bird Ventures' Camp Bird Mine; and 52 on maintenance at AMAX's Climax property.

Environment.—Following a court decision, Union Carbide Corp. and its wholly owned subsidiary, Umetco Minerals Corp., began paying Colorado for cleanup of the Uravan uranium-vanadium mine and mill site in Montrose County. In March, the company paid $1.07 million and will eventually pay a total of $2.75 million. Colorado officials may use parts of the Uravan site for disposal of radioactive wastes from Denver-area radium sites. The Colorado Department of Health will oversee the $40 million rehabilition program at Uravan.

The State and Cotter Corp. agreed at yearend to a cleanup plan for a contaminated area at Cotter's uranium mill near Canon City, Fremont County. The mill was closed in January 1987.

Newmont Mining Corp. and Idarado Mining Co. paid a $69,000 penalty for allowing a cancer-causing chemical to leak from the defunct Idarado Mine in Telluride according to the U.S. Environmental Protection Agency (EPA). The two firms also agreed to clean up all spills of polychlorinated biphenyls (PCB) at the mine, which closed in 1972. The Idarado, a producer of gold, silver, lead, zinc, and copper, used PCBs as a cooling agent in transformers, voltage regulators, and other electrical devices before the 1976 ban on this chemical.

Exploration Activities.—Homestake Mining Co. reported in its 1987 annual report that it was continuing underground exploration at its Northern Amethyst silver-gold vein deposit in the Creede mining district. Ore grade mineralization in the veins was identified, but vein continuity was not established.

The first major exploration program to be conducted at the Camp Bird Mine in Ouray and San Miguel Counties since 1910 began in 1987. A total of 60,000 feet of core was to be drilled through the eastern and western extensions of the Camp Bird vein by yearend 1988. Chipeta Mining Co. (a subsidiary of Western Mining Corp. of Australia) confirmed the mine's proven reserves assaying 0.25 troy ounce of gold per ton.

Legislation and Government Programs.—At the first Colorado Mining Summit, held in November, the Governor requested a balance between environmental issues and economic growth. The State Government was asked to rewrite the tax structure into a more "competitive framework," promote an effective transportation system, and design a more efficient permitting process to boost mining in Colorado. The Governor actively encouraged a resurgence of metal mining and was credited with influencing several large mining companies to consider moving their headquarters to Denver.

The U.S. Bureau of Mines and the U.S. Geological Survey jointly published several reports covering the mineral resources of wilderness study areas in Delta, Hinsdale, Jackson, Mesa, Montrose, and Routt Counties.[3]

The Bureau of Mines delineated five gold and silver deposits and a molybdenum deposit in the Collegiate Peaks Wilderness study area. Gold, molybdenum, silver and a large-tonnage deposit of chemical-grade limestone were delineated in the Holy Cross Wilderness study area.[4]

The tenth U.S. Court of Appeals in Denver ruled that the U.S. Department of Energy must restrict its enrichment of foreign uranium to protect the domestic uranium industry. The decision was hailed by some uranium-mining officials as a big step toward revitalizing uranium (and byproduct vanadium) mining in the United States.

In recognition of its being "the historical heart, future showcase, and research center of the mining industry in America," the National Mining Hall of Fame and Museum in Leadville sought a national charter, which was expected to be approved by Congress in 1988.

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REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Gold.—Except for sand and gravel, gold exceeded the value of any other mined commodity in Colorado in 1987. Gold output was valued at $80 million, about 81% higher than that of 1986, with production rising 49% above the 1986 level to 178,795 troy ounces. The average price of gold was $447.95 per troy ounce, nearly $80 higher than in 1986. Reported ore grades at operating mines were low, however, running 0.01 to 0.20 ounce per short ton. Several operations were using the U.S. Bureau of Mines developed heap-leaching recovery process, which has significantly aided in revitalizing the gold-mining industry.

AMAX formed a new subsidiary, AMAX Gold Inc., and Royal Resources Corp. decided to abandon the oil business, change its name to Royal Gold Inc., and become a joint-venture partner at the venerable Camp Bird Mine. Several firms planned to move, or have moved, their headquarters to Denver because of access to transportation and mining-related businesses, such as equipment suppliers, assay laboratories, large research libraries such as those of the U.S. Geological Survey, U.S. Bureau of Mines, and Colorado School of Mines. Even companies without mining prospects in Colorado were finding Denver an attractive location.

During the year, gold production was reported by the Bessie G, Black Cloud, Camp Bird, Comstock Lake, Cross, Lucky Strike, May Day, Portland open pit, Summitville open pit, Sunnyside, and Waco No. 1 Mines.

Battle Mountain Gold Co. of Houston, TX, acquired the San Luis project in Costilla County for $6 million in cash and securities in September 1987. Battle Mountain completed 243 drill holes by November and estimated reserves were 20 million tons grading 0.034 ounce of gold per ton, or 680,000 ounces of gold.

Renovation of the Camp Bird Mine, Ouray County, proceeded rapidly at yearend. Royal Gold and Chipeta Mining had recently acquired the mine from Federal Resources Corp. Four production stopes were being prepared and milling began in December at the rate of 140 tons per day.

Vancouver-based Galactic Resources Ltd.'s Summitville Mine in Rio Grande County exceeded the company's projected gold recoveries for 1987 by more than 8,000 troy ounces. Gold output reached 88,320 ounces. It was Colorado's No. 1 gold producer in 1987 and ranked 16th in the Nation.

Cripple Creek and Victor Gold Mining Co., a joint venture of Golden Cycle Gold Corp. and Texasgulf Minerals and Metals Inc., heap leached ore to produce 28,065 troy ounces of gold in 1987 at its mine dump project in Teller County, according to Golden Cycle's 1987 annual report. About 900,000 tons of the original 3 million tons of mine dump material remain. Mined ore from the Portland open pit of the joint venture was stockpiled completion of a leach pad and add-on construction to the old Carlton Mill, which had not been operated for more than a decade. The gold recovery plant, expanded to accommodate the input from the 300-ton-per-day flotation mill, was constructed within the old Carlton mill building. Gold recovery will be by cyanide leaching and electrowinning.

Franklin Consolidated Mining Co. reopened the Bates-Hunter Mine near Central City, Gilpin County. Redevelopment was along a "500-foot-thick" ore zone containing gold (0.35 ounce per ton) and silver. No production ore had been shipped by yearend.

Jascan Resources Inc. (60% partner) and Atlantic Goldfields Inc. (40%) targeted early 1989 for the first production from their Dawson project near Canon City, Fremont County. Reserves were estimated to be 1.03 million short tons of ore grading 0.15 ounce of gold per ton.

Nevada Goldfields Corp. anticipated production in 1989 at its proposed Empire open pit mine and heap-leach operation in Clear Creek County. Capital costs were estimated to be $14 million, production capacity 2,000 tons per day, and operating costs $270 per ounce.

Silver State Mining Corp. estimated output of 25,000 troy ounces of gold and 7,962 ounces of silver from its all-weather vat-leach recovery process plant at the Victor Mine in Teller County. Silver State subsequently sold the Victor Mine to Nerco Minerals Co., which expanded the vat system from three to six vats.

Molybdenum.—In response to oversupplies, low prices, and a general slowdown in the steel industry throughout the Nation during the past 3 years, molybdenum output in Colorado, the world's major source of

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the metal, declined and capacity was reduced at Climax Molybdenum Co.'s Henderson and Climax Mines. Output in 1987, according to AMAX's annual report, was about 27 million pounds of concentrate, compared with 102 million pounds in 1980.

The Climax open pit was placed on a care-and-maintenance basis in 1986, but was credited in 1987 with recovering 2.2 million pounds of concentrate produced from ore with an average grade of 0.48% molybdenum disulfide. The Henderson underground mine recovered 24.9 million pounds of concentrate produced from ore with an average grade of 0.46% molybdenum disulfide. Employment at the Climax Mine decreased from about 3,000 persons in 1980 to 50 in 1987; at Henderson, from 2,000 to 400.

Proven and probable ore reserves at the Henderson Mine were estimated to be 221 million short tons, averaging 0.37% molybdenum disulfide; and at the Climax open pit, 137 million tons, averaging 0.32% molybdenum disulfide.

Silver.—Colorado mines produced 34% more recoverable silver in 1987 than they had in 1986. Silver production was reported from the Bessie G, Black Cloud, Comstock Lake, Cross, Lucky Strike, May Day, Portland, Summitville, Sunnyside, and Waco No. 1 Mines. The Sunnyside Mine was the largest producer and ranked 21st among the Nation's top 25 silver mines. Silver output at the Summitville open pit mine in Rio Grande County totaled 70,721 troy ounces, about 8% of the State's output.

Silver began the year priced at $5.44 per troy ounce and averaged $7.01 for the year. Silver mines with no gold coproduct did not operate because silver prices were too low to be profitable. For example, Homestake's Bulldog Mine and mill in Creede, Mineral County, the State's largest silver mine, continued in a standby mode through 1987.

Other Metals.—Black Cloud, Cross, and Sunnyside Mines reported copper and lead production. Lead output rose 35%, the highest since 1983, and the total value of lead was up 120% from that of 1986. The Black Cloud Mine (ASARCO Incorporated's Leadville Unit) and the Sunnyside Mine were ranked eighth and ninth among the Nation's 25 leading lead-producing mines.

CF&I Corp. of Pueblo produced steel from scrap metal at an annual rate of about 600,000 tons. No iron ore production was reported in the State in 1987; Pitkin County iron ores have not been produced since 1986.

Scandium was recovered by Boulder Scientific Co. from tungsten concentrates derived from the processing of Climax Mine molybdenum ores and ores from out of State. Boulder Scientific, in Mead, Weld County, was one of two companies in the United States known to be producing scandium oxide.

Cleanup at uranium-vanadium mills and dumps in the western part of the State provided about 55% more vanadium to the market than in 1986. Price, however, fell about 5%, as various vanadium substitutes were used in alloying metals. Umetco Minerals reopened a few small mines in Colorado and shipped ore to its White Mesa mill at Blanding, UT.

Molycorp Inc. announced plans to double the yttrium oxide capacity at its Louviers plant in Douglas County. Yttrium oxide is used in phosphors and in high-temperature ceramic and refractory applications.

Zinc was produced from the Black Cloud and Sunnyside underground mines.

INDUSTRIAL MINERALS

Industrial mineral production consisted of clays, gem stone, gypsum, peat, perlite, pyrite, construction and industrial sand and gravel, and crushed and dimension stone.

Cement.—Portland cement output and value from Colorado's three cement plants declined from 1985 through 1987, and masonry cement output and value has declined since 1984.

Ideal Basic Industries Inc., a Denver-based subsidiary of Holderbank Finançiere Glaris Ltd. of Switzerland since September 1986, stated that company revenues in 1987 were down 10% in the Rocky Mountain region and cement consumption in Colorado was down 24%. According to Ideal Basic's 1987 annual report, weak consumption of cement by the energy and agricultural sectors was the principal factor contributing to the decline in average cement price by $2.35 per ton to $50.63 per ton.

Clays.—Colorado was a relatively small producer of clays, with about 0.6% of the Nation's total output. Output and total value increased significantly from levels reported for 1986. About 99% of production was common clay. Some fire clay, kaolin, and small amounts of swelling and nonswelling bentonite also were produced.

Clay production came from 30 pits in 7 counties—more than two-thirds of clay

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values were from Boulder, Douglas, Elbert, and Jefferson Counties. Leading companies were Lakewood Brick and Tile Co., Robinson Brick Co., and General Refractories Co.

Colorado clays were used for common, face and refractory brick, refractory grogs and calcines, and waterproof seals. Average unit price of clays per short ton ranged from $5.58 for common clay to $50.74 for refractory kaolin.

Despite the sluggish Colorado construction industry and gloomy economic forecasts made in the spring of 1987, Robinson Brick Co. moved to expand operations in order to assure a large inventory and more colors. Robinson Brick's market area ranges widely over the Nation because of its product variety. Production was more than 1.5 million modular brick per week. The company fired up its second kiln in April and started two-shift operations for the first time since September 1984.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Sand and gravel and crushed stone operators met strong opposition from residents when they applied for permits to extend their pits and quarries or to add to the number of years over which their facilities would be permitted to operate. Interpretations of State law were argued in county courts, among them, Boulder County, where county residents opposed expansion to 200 acres of a 10-acre gravel pit that had been in operation since 1969.

Industrial.—The State's two industrial sand companies each operated a pit, one in Arapahoe County, the other in El Paso County. Industrial sand was sold for sandblasting, filtration, roofing granules, and miscellaneous.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone was produced in 16 of Colorado's 63 counties. Output increased less than 1% over that estimated for 1986 but was more than 14% higher than that reported for 1985. Rock types quarried were andesite, granite, limestone, sandstone, and volcanic cinder. Crushed granite provided 56% of the State's total crushed stone output. There were 38 quarries operated by 27 companies.

Table 3.—Colorado: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	233	938
Filter stone	26	86
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,498	6,268
Bituminous aggregate, coarse	780	3,409
Bituminous surface-treatment aggregate	293	1,214
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	559	2,435
Screening, undesignated	286	1,145
Coarse and fine aggregates:		
Graded road base or subbase	894	3,598
Unpaved road surfacing	314	774
Crusher run or fill or waste	70	180
Other construction[2]	115	366
Special: Other miscellaneous[3]	923	5,061
Other unspecified[4]	2,052	7,990
Total[5]	8,045	33,465

[1]Includes granite, limestone, sandstone, and volcanic cinder, and miscellaneous stone.
[2]Includes coarse aggregate (large), railroad ballast, combined coarse and fine aggregates, terrazzo and exposed aggregate.
[3]Includes agricultural limestone, poultry grit and mineral food, other agricultural uses, cement manufacture, lime manufacture, sulfur oxide removal, mine dusting and acid water treatment, asphalt fillers or extenders, other fillers or extenders and roofing granule.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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Uses, in descending order of quantity consumed, were concrete aggregate, graded road base material, cement materials, bituminous aggregate, and 21 other uses. The average price per ton for crushed stone was $4.16.

The Denver Tech Center's application to open a 130-acre crushed stone quarry at Red Mesa in southern Jefferson County was stalled by objections from residents and Martin Marietta Corp. Martin Marietta predicted that quarry blasting would significantly and adversely affect top secret space weapon research at its laboratory 3.5 miles north of Red Mesa.

In 1985, the U.S Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the six Colorado districts depicted in figure 1.

Table 4.—Colorado: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	--	--	W	W	W	W
Coarse aggregate, graded[2]	(3)	(3)	--	--	--	--
Fine aggregate (-3/8 inch)[4]	--	--	--	--	--	--
Combined coarse and fine aggregates[5]	--	--	--	--	--	--
Other construction	15	53	--	--	--	--
Agricultural[6]	--	--	W	W	--	--
Chemical and metallurgical[7]	--	--	W	W	--	--
Special[8]	--	--	--	--	--	--
Other micellaneous	--	--	--	--	--	--
Other unspecified[9]	132	991	W	W	--	--
Total[10]	148	1,044	W	W	W	W

Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	234	933	(3)	(3)	--	--
Coarse aggregate, graded[2]	2,217	9,477	(3)	(3)	--	--
Fine aggregate (-3/8 inch)[4]	764	3,255	(3)	(3)	--	--
Coarse and fine aggregates[5]	1,072	3,904	164	494	91	281
Other construction	--	--	480	1,910	--	--
Agricultural[6]	--	--	(11)	(11)	--	--
Chemical and metallurgical[7]	10	55	(11)	(11)	(12)	(12)
Special[8]	--	--	(11)	(11)	--	--
Other miscellaneous	--	--	714	2,668	--	--
Other unspecified[9]	1,070	4,122	552	1,556	17	206
Total[10]	5,367	21,746	1,910	6,627	108	487

W Withheld to avoid disclosing company proprietary data.
[1]Includes riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Withheld to avoid disclosing company proprietary data; included with "Other construction."
[4]Includes stone sand (bituminous mix or seal), and fine aggregate (screen).
[5]Includes graded road fixed base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, crusher run or fill or waste, and combined coarse and fine aggregates.
[6]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[7]Includes cement manufacture, lime manufacture, and sulfur oxide removal.
[8]Inclues mine dusting, asphalt filler, other fillers or extenders, and roofing granules.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.
[11]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[12]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."

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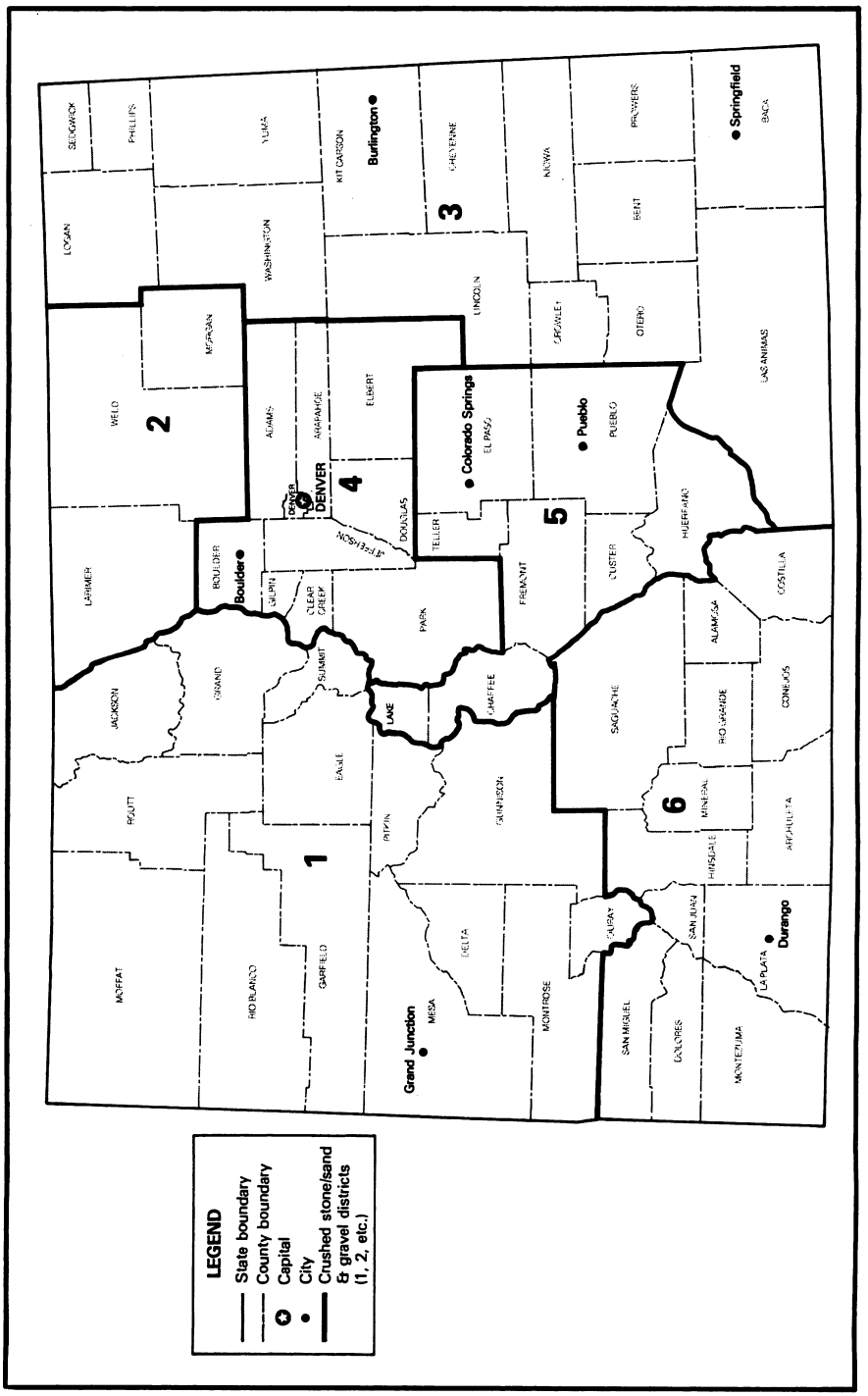

Figure 1.—Aggregate-producing districts in Colorado.

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Dimension.—Three firms reported dimension stone production from four quarries along the Front Range, northwest of Denver. Dimension sandstone was quarried by one firm in Boulder County and two firms in Larimer County. Also in Larimer County near Pinewood Springs, a small amount of dimension granite was quarried. Colorado dimension stone averaged $44.32 per short ton. In decreasing order of price, uses were rough blocks, cut or veneer stone, sawed stone, dressed flagstone, and irregular-shaped shaped stone.

Other Industrial Minerals.—Deep purple, doubly terminated amethyst was hand-mined from a pit on the 20-acre End of the Rainbow claim, 4 miles west of Red Feather Lakes, Larimer County. Anchor Coal Co. of Tulsa, OK, spent about $1 million to redevelop the long-closed Blue Wrinkle surface mine, a source of low grade lapis lazuli. This mine in Gunnison County was to be reopened in the summer of 1988 as an underground mine. Green turquoise continued to be produced from the King Turquoise Mine in Conejos County.

Crude gypsum output has fallen steadily, 1984-87, but price per short ton recovered to $7.50, 43 cents higher than that of 1986. Three companies produced crude gypsum at mines in Eagle, Fremont, and Larimer Counties. Domstar Inc. acquired the mines and wallboard plants, including property in Fremont County, formerly owned by Genstar Gypsum Products Co.

Lime production has continued to increase since 1985, but was still less than production in 1984. Price per ton and total value of lime declined significantly from 1986 figures. Three quicklime plants were operated during the year: Western Sugar Co. at Morgan and Weld Counties and Calco Inc. at Chaffee County. Lime is used in sugar refining as well as in other processes.

A large reserve of nahcolite, naturally occurring sodium bicarbonate, north of Rifle in Rio Blanco County was leased by Wolf Ridge Corp., a wholly owned subsidiary of Industrial Resources Inc. of Lakewood. The property was estimated to contain 6 billion short tons of nahcolite. A solution-mining plan was proposed to extract the nahcolite, which would be used as a cattle feed supplement, in powerplant scrubbers, pharmaceuticals, and glassmaking.

At least three peat operations were active in 1987. Colorado Peat Industries in Boulder County and Universal Peat Sand and Gravel Inc. in Park County cut peat and sold it in bulk. Glacier View Peat Corp. in Chaffee County sold its output packaged. Reported output for the State was down significantly.

Perlite was exfoliated by Grefco Inc.'s Building Products Div. at its Antonito plant in Conejos County. Persolite Products Inc. reported output from its Florence plant in Fremont County. Crude ore was from its Rosita Mine.

Two firms in Leadville produced pyrite. Apache Pyrite Joint Venture (Apache Energy & Minerals Co.) continued to reprocess a tailings pile south of the town of Leadville to recover sulfur, which was sold for use in the glass-coloring, abrasive, battery, steel, and metal-processing industries. The Apache operation simultaneously cleaned up an unsightly area. Leadville Research and Development reported pyrite production from a mine in Lake County, but use was not specified. Plans for a sulfur mine west of Creede in Mineral County were abandoned for lack of financing.

W. R. Grace & Co. exfoliated vermiculite from out-of-State sources at its plant in Denver. Vermiculite was used principally in fireproofing and also in concrete and plaster aggregates, in loose fill and block insulation, and in horticulture agriculture.

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[1]State Mineral Officer, Bureau of Mines, Denver, CO.

[2]Chief, Minerals and Mineral Fuels Resources, Colorado Geological Survey.

[3]Sanford, R. F., R. I. Grauch, K. Hon, D. J. Bove, V. J. S. Grauch, and S. L. Korzeb. Mineral Resources of the Redcloud Peak and Handies Peak Wilderness Study Areas, Hinsdale County, Colorado. U.S. Geol. Surv. Bull. 1715-B, 1987, pp. B1-B35.

Snyder, G. L., L. L. Patten, and J. J. Daniels. Mineral Resources of the Mount Zirkel Wilderness and Northern Park Range Vicinity, Jackson and Routt Counties, Colorado. U.S. Geol. Surv. Bull. 1554, 1987, 236 pp. (Supersedes U.S. Geol. Surv. Open File Report 83-891.) Chap. B, Mine Appraisal, by L. L. Patten, U.S. BuMines., pp. 57-107. Toth, M. I., C. G. Patterson, D. M. Kulik, and R. A. Schreiner. Mineral Resources of the Dominguez Canyon Wilderness Study Area, Delta, Mesa, and Montrose Counties, Colorado. U.S. Geol. Surv. Bull. 1736-A, pp. A1-A10.

[4]Baskin, G. D. Mineral Resources of the Collegiate Peaks Wilderness, Chaffee, Gunnison, Lake, and Pitkin Counties, Colorado. BuMines MLA 45-87, 1987, 104 pp.

Lundby, W., and S. D. Brown. Mineral Resources of the Holy Cross Wilderness, Eagle, Lake, and Pitkin Counties, Colorado. BuMines MLA 3-87, 1987, 162 pp.

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Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ideal Basic Industries Inc.[1]	Box 8789 750 17th St. Denver, CO 80201	Plants	Fremont and Larimer.
Southwestern Portland Cement Co.[1]	1111 South Colorado Blvd. Denver, CO 80222	Plant	Boulder.
Clays:			
General Refractories Co	600 Grant St., Room 3000 Pittsburgh, PA 15219	Pits	Pueblo.
Lakewood Brick and Tile Co	1325 Jay St. Lakewood, CO 80214	Pits and plant	Fremont and Jefferson.
G. W. Parfet Estate Inc	1213-1/2 Washington Ave. Golden, CO 80401	Pits	Jefferson.
Robinson Brick Co	Box 5243 Denver, CO 80217	Pits and plant	Douglas, Elbert, El Paso, Jefferson.
Gold:			
ASARCO Incorporated[2]	Box 936 Leadville, CO 80461	Mine and mill	Lake.
Cripple Creek and Victor Gold Mining Co.[3]	Box 191 Victor, CO 80860	Mine dump heap leaching.	Teller.
Summitville Consolidated Mining Co. Inc., a subsidiary of Galactic Resources Inc.[3]	Box 2G Del Norte, CO 81132	Open pit, vat leaching, carbon-pulp plant.	Rio Grande.
Sunnyside Gold Corp., a subsidiary of Echo Bay Mines Ltd.[2]	Box 177 Silverton, CO 81433	Mine and mill	San Juan.
Gypsum:			
Domtar Gypsum	1173 State Hwy. 120 Florence, CO 81226	Mine and plant	Fremont.
Lime:			
Calco Inc	Box 1044 Salida, CO 81201	do	Chaffee.
The Western Sugar Co., a subsidiary of Tate and Lyle PLC.	555 17th St. Denver, CO 80202	Plants	Morgan and Weld.
Molybdenum:			
AMAX Inc.[4]	1707 Cole Blvd. Golden, CO 80401	Mines and mills	Clear Creek, Grand, Lake.
Peat:			
Universal Peat Sand & Gravel Inc	1557 South Ingalls St. Lakewood, CO 80226	Bog	Park.
Perlite:			
Grefco Inc., Building Products Div	Box 308 Antonito, CO 81120	Plant	Conejos.
Persolite Products Inc	Box 105 Florence, CO 81226	Mine and plant	Custer and Fremont.
Sand and gravel:			
Castle Concrete Co	Box 2379 Colorado Springs, CO 80901	Pits and plants	El Paso and Pueblo.
Cooley Gravel Co. (J. L. Shiely Co.)[1]	Box 5485 Terminal Annex Denver, CO 80217	do	Adams, El Paso, Jefferson.
Albert Frei & Sons Associates	11521 Brighton Rd. Henderson, CO 80640	do	Adams, Clear Creek, Garfield, Weld.
Western Mobile Premix Co.[1]	Box 5183TA Denver, CO 80217	do	Various (9 counties).
Western Paving Construction Co	Box 21649 Denver, CO 80221	do	Boulder and Weld.
Stone:			
Asphalt Paving Co	14802 West 44th Ave. Golden, CO 80401	Quarries	Jefferson.
Rocky Mountain Rose Red Inc	North Star Route Lyons, CO 80540	Quarry	Larimer.

[1]Also stone.
[2]Also copper, lead, silver, and zinc.
[3]Also silver.
[4]Also tungsten.

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The Mineral Industry of Connecticut

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Robert J. Altamura[2]

The value of nonfuel mineral production in Connecticut in 1987 was $122.3 million, a 52% increase compared with that of 1986. Crushed stone and sand and gravel continued to be the two leading mineral commodities produced. In 1987, the combined value of these two commodities accounted for 93% of the State's total mineral production value.

Trends and Developments.—All facets of construction activity grew in the State, residential and commercial buildings leading the way. Aggregate producers were extremely busy and contractors were often hard pressed to find ample supplies. In 1987, Connecticut was also in the fourth year of a 10-year, $10 billion State program of infrastructure improvements. Infrastructure improvements included street paving and repairs on roads, bridges, sewage, and water systems.[3] Although no cement is produced in Connecticut, shipments into the State for construction purposes remained at about the 1986 record-high level of nearly 1 million tons.

Table 1.—Nonfuel mineral production in Connecticut[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	106	$632	157	$975	W	W
Gem stones	NA	W	NA	2	NA	$2
Sand and gravel (construction) thousand short tons	e6,000	e21,000	7,254	25,984	e8,400	e37,000
Stone:						
Crushed ---------- do	7,277	43,937	e7,700	e45,800	11,412	76,668
Dimension ---------- do	20	1,285	e24	e1,653	18	1,646
Combined value of feldspar, mica (scrap), sand and gravel (industrial), and values indicated by symbol W ----------	XX	5,532	XX	6,040	XX	6,959
Total	XX	72,386	XX	80,454	XX	122,275

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; not included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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In the advanced materials sector, Howmet Corp., Greenwich, and Ceramiques Techniques Desmarquest (CTD), Trappes, France, formed a joint venture to manufacture and market advanced ceramic products for commercial and military applications in North America. The company, named Hd Ceramics, will be based in Howmet's executive offices in Greenwich.

Table 2.—Nonfuel minerals produced in Connecticut in 1986, by county[1]

County	Minerals produced in order of value
Fairfield	Sand and gravel.
Hartford	Sand and gravel, clays.
Litchfield	Sand and gravel.
Middlesex	Feldspar, sand and gravel, clays, mica.
New Haven	Sand and gravel.
New London	Do.
Tolland	Do.
Windham	Do.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—Continuing concern about the quality of the State's air, land, and water resources resulted in the passage of several laws relating to hazardous waste and resource recovery facilities. Bills signed into law concerning hazardous waste disposal included Public Act (PA) 87-150, PA 87-233, PA 87-332, PA 87-475, and PA 87-561. Bills enacted concerning resource recovery facilities included PA 87-451, PA 87-465, PA 87-489, and PA 87-556. The bills are described in capsule summary form in the "Classified Index of Legislation Enacted by the 1987 General Assembly."[4] Legislation (PA 87-540) was also passed that established a mechanism for the siting of a regional low-level radioactive waste disposal facility. Once enacted, PA 87-438 created civil penalties for violations of coastal management, stream channel encroachment, and navigable water laws regarding removal of sand and gravel, dredging, and stream channel encroachment.

The Connecticut Department of Environmental Protection's plan, "Environment/2000" was approved by the Governor during the year. This environmental management plan includes strategies to (1) determine the availability and use of nonrenewable natural resources, (2) improve information on mineral and soil resources, (3) develop regulations for land-development and mineral extraction, and (4) acquire or set aside areas with critical minerals or soils that should be reserved in the public interest.

The Connecticut Geological and Natural History Survey (CGNHS) continued programs on the collection, interpretation, and dissemination of information on the State's natural resources. Major efforts for the year included topographic, bedrock, and surficial geological mapping; soils investigations; a study of the geology of Long Island Sound;[5] and a radon investigation throughout the State.[6] A map and accompanying report of the mines and quarries of Connecticut showing the location of more than 600 active and abandoned mineral sites was also published during the year.[7]

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Clays.—Two companies mined common clay for use in the manufacture of common and face brick. K-F Brick Co. mined Pleistocene glacial clay near South Windsor and also quarried Jurassic Age shell near Suffield, both in Hartford County. The Michael Kane Brick Co. operated an open pit mine in Middlesex County.

Feldspar.—In feldspar production Connecticut ranked second nationally after North Carolina. The Feldspar Corp. operated three open pit quarries and a froth flotation plant in the old Middletown Pegmatite District in Portland and Middletown, Middlesex County. Production remained essentially the same as that of 1986. The feldspar was used by the glass and ceramics industry principally as a flux.

Mica.—The Feldspar Corp. recovered scrap mica as a byproduct of feldspar-mining operations in Middletown, Middlesex County. Production was nearly double that of 1986. The mica was sold as a filler and as an additive for well-drilling mud.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

The value of construction sand and gravel has historically been the second-leading

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mineral commodity produced in terms of value. Estimated production in 1987 was 8.4 million tons valued at $37 million. This represented an increase of 16% and 42% in output and value, respectively, over that of 1986. Production was reported in all eight counties in the State. Major uses were for construction and roadbuilding.

Industrial.—Two companies produced industrial sand in the State in 1987. The Feldspar Corp. processed industrial sand as a byproduct of feldspar refining in Middletown, Middlesex County, and U.S. Silica Co. of Connecticut operated a quarry near North Stonington, New London County. Principal uses were for roofing granules, glass products, and filtration.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone was the State's leading commodity produced. It accounted for almost two-thirds of the State's total mineral value. Crushed stone production totaled 11.4 million tons valued at $76.7 million, a 68% increase in output and 68% increase in value compared with 1986 estimates.

Table 3.—Connecticut: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Other coarse aggregate	15	104
Coarse aggregate, graded: Concrete aggregate, coarse	321	2,023
Fine aggregate (-3/8 inch): Screening, undesignated	30	180
Coarse and fine aggregates:		
Unpaved road sufacing	42	232
Terrazzo and exposed aggregate	W	44
Other construction[2]	872	4,993
Agricultural: Agricultural limestone	W	247
Other unspecified[3]	10,131	68,847
Total[4]	11,412	76,668

W Withheld to avoid disclosing company proprietary data; included with "Other construction."

[1]Includes limestone, traprock, dolomite, and gneiss.

[2]Includes riprap and jetty stone, filter stone, coarse aggregate (graded), bituminous aggregate (coarse), fine aggregate, combined coarse and fine aggregates, graded road base or subbase, a small amount of agricultural limestone, and data indicated by symbol W.

[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[4]Data may not add to totals shown because of independent rounding.

Dimension.—Dimension granite was quarried in New Haven County, and dimension granite and quartzite were quarried in Tolland and Windham Counties. The stone was sold as irregular-shaped stone, rough blocks, and cut stone.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

[2]Geologist, State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Hartford, CT.

[3]Rock Products. Aggregates: 1988 Pegged To Be "Iffy" Year. V. 90, No. 12, Dec. 1987, pp. 45-46.

[4]Greater Hartford Chamber of Commerce. The Classified Index of Legislation Enacted by the 1987 General Assembly. For information on individual bills, write to the Greater Hartford Chamber of Commerce, 250 Constitution Plaza, Hartford, CT 06103.

[5]Lewis, R., and S. W. Needell. Map showing the Quaternary Geology of East-Central Long Island Sound. U.S. Geol. Surv. Miscellaneous Field Studies Map MF-1939B, 1987, 1:125,000 scale.

[6]Thomas, M. A. A Connecticut Radon Study—A Progress Report: Radon in Ground Water. Ed. by Barbara Graves (Proc. of the National Water Well Assoc. Conf., Somerset, NJ, Apr. 7-9, 1987), pp. 347-362.

[7]Altamura, R. J. Bedrock Mines and Quarries of Connecticut. Connecticut Geological and Natural History Survey, Natural Resources Atlas Series, 1987, 1:125,000 scale map plus a 41-pp booklet.

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Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
The Michael Kane Brick Co	654 Newfield St. Middletown, CT 06457	Pit and plant	Middlesex.
K-F Brick Co	Box 375 East Windsor Hill, CT 06028	Mine and plant	Hartford.
Feldspar:			
The Feldspar Corp.[1]	Box 99 Spruce Pine, NC 28777	Mines and plant	Middlesex.
Sand and gravel (1986):			
Construction:			
Dan Beard Inc	Box 71, Mary St. Shelton, CT 06484	Pit and plant	New Haven.
Connecticut Sand & Stone Corp	7 West Main St. Plainville, CT 06062	Pit and plants	Hartford and Litchfield.
D.B.D. Inc	Box 62 Brookfield, CT 06805	Pit and plant	Fairfield.
De Siato Sand & Gravel Corp	999 Stafford Rd. Storrs, CT 06268	Pit	Tolland.
R. A. Rawson Sand & Gravel Inc	R.F.D. 1 Putnam, CT 06260	Pits and mill	Windham.
Industrial:			
U.S. Silica Co. of Connecticut	Box 577 Ottawa, IL 61350	Pit and plant	New London.
Stone:			
Crushed:			
Edward Balf Co	Box 11190 Newington, CT 06111	Quarry	Hartford.
O&G Industries Inc	23 Casson Ave. Box 907 Torrington, CT 06790	Quarries	Litchfield and New Haven.
Roncari Industries Inc	1776 South Main St. East Granby, CT 06026	Quarry	Hartford.
Tilcon Tomasso Inc	Box 67 909 Foxen Rd. North Branford, CT 06471	do	Hartford, New Haven, Windham.
York Hill Trap Rock Quarry Co	Westfield Rd. Meriden, CT 06450	do	New Haven.
Dimension:			
Castellucci & Sons Inc	West River St. Providence, RI 02904	do	Do.
R. B. Marriott & Sons Co	Box 67 Oneco, CT 06373	do	Windham.
Wayne C. Williams General Construction Inc.	R.F.D. 1, Conklin Rd. Stafford Springs, CT 06076	do	Tolland.

[1]Also crude mica and industrial sand.

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The Mineral Industry of Delaware

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Delaware Geological Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

The value of construction sand and gravel production in Delaware in 1987 was $6.4 million. Output and value data for magnesium compounds and greensand, which were also produced, were excluded from the State total to avoid disclosing company proprietary data. Delaware was one of six States producing magnesium compounds and one of only two reporting greensand marl production in 1987.

Trends and Developments.—The introduction of high-tech materials such as new polymer composites presents significant competitive challenges and opportunities in conventional mineral markets according to a U.S. Bureau of Mines report entitled, "The Impact of Advanced Materials on Conventional Nonfuel Mineral Markets: Selected Forecasts for 1990-2000."[2] The Center for Composite Materials at the University of Delaware continued research on composites technology that included studies and reports on (1) fracture toughness and fatigue on an alumina-fiber reinforced magnesium metal-matrix composite, (2) cure behavior of thermosetting resin composites, (3) resin impregnation during the manufacturing of composite materials, and (4) diaphragm forming of carbon-fiber-reinforced thermoplastic composite materials. Lanxide Corp., Newark, DE, developed ceramic materials for high-tech applications using an oxidation reaction process. This process allows for the creation of composite materials because some metal remains in the product. Ceramic metal composites are designed for use in materials that have deficiencies in terms of durability, corrosion, temperature resistance, and chemical breakdown.

Table 1.—Nonfuel mineral production in Delaware[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	--	--	NA	$1	NA	$1
Marl (greensand) -- thousand short tons	2	$29	1	12	W	W
Sand and gravel (construction) ---- do ----	e1,300	e4,000	1,547	4,156	e2,300	e6,400
Total[2]	XX	4,029	XX	4,169	XX	6,401

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Delaware produced minor quantities of greensand marl, magnesium compounds, and construction sand and gravel compared with national output totals for these commodities. In addition, the State manufactured and processed minerals including gypsum, sulfur, and titanium dioxide. Locations of these operations are listed in table 2.

Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

The construction industry provided the greatest source of demand for nonfuel minerals in the State. Output of 2.3 million short tons of sand and gravel in 1987 was the highest quantity produced since 1973 and reflected the demand generated from multimillion-dollar construction projects in Dover, Newcastle, Smyrna, and Wilmington. Sand and gravel also was shipped in from other States. In addition, sources outside Delaware provided crushed stone and cement for use in building and road construction.

METALS

Phoenix Steel Corp., Claymont, the State's only raw steelmaking facility, was shut down in February. The firm filed for protection under chapter 11 of the Federal Bankruptcy Code in April, and the plant remained for sale at yearend. The operation contributed an estimated $60 million to the Claymont area economy in 1986 and employed about 750 workers before closing.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

[2]Balazik, R. F., and B. W. Klein. The Impact of Advanced Materials on Conventional Nonfuel Mineral Markets: Selected Forecasts for 1990-2000. BuMines IC 9150, 1987, p. 18.

Table 2.—Principal producers

Commodity and company	Address	Type of activity	County
Greensand:			
Contractors Sand & Gravel Co. Inc.[1]	Box 2630 Wilmington, DE 19805	Pit	New Castle.
Gypsum (calcined):			
Georgia-Pacific Corp., Gypsum Div	Wilmington Marine Terminal Box 310 Wilmington, DE 19899	Plant	Do.
Magnesium compounds:			
Barcroft Co	40 Cape Henlopen Dr. Lewes, DE 19958	Plant (pharmaceutical-fine chemical).	Sussex.
Sand and gravel (construction):			
Dover Equipment & Machine Co	113 West 6th St. New Castle, DE 19720	Dredge	Kent.
Parkway Gravel Inc	4048 New Castle Ave. New Castle, DE 19720	Pit	New Castle.
Howard L. Ritter & Sons	Box 716 Lewes, DE 19958	Pit	Sussex.
Staytons Sand & Gravel Inc	Box P Felton, DE 19943	Pit	Kent.
Steel:			
Phoenix Steel Corp	4001 Philadelphia Pike Claymont, DE 19703	Mill (plate)	Do.
Sulfur (recovered):			
Texaco Inc	Wrangle Hill Rd. Delaware City, DE 19706	Refinery (petroleum).	Do.
Titanium dioxide:			
E. I. du Pont de Nemours & Co. Inc	Edgemoor, DE 19809	Plant (chemical).	Do.

[1]Also sand and gravel.

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The Mineral Industry of Florida

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Florida Bureau of Geology for collecting information on all nonfuel minerals.

By James R. Boyle[1] and Walter Schmidt[2]

The value of nonfuel mineral production in Florida in 1987 was $1.3 billion, an increase of $56 million over that of 1986. The State ranked fourth nationally in output of nonfuel minerals with industrial minerals accounting for nearly all of the value. Principal minerals produced were cement, clays, phosphate rock, sand and gravel, and stone.

Florida remained the predominant producer of phosphate rock nationally, and with North Carolina supplied nearly 90% of the domestic phosphate rock output. The State ranked high in output of other industrial minerals, ranking first in production of peat, second in fuller's earth, third in crushed stone and masonry cement, fifth in industrial sand, and seventh in portland cement and construction sand and gravel. Additionally, ilmenite, rutile, staurolite, and zircon concentrates were produced only in Florida, as coproducts of mineral sands operations.

Table 1.—Nonfuel mineral production in Florida[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	316	$17,137	352	$21,269	390	$24,069
Portland do.	3,282	148,908	3,189	147,643	3,565	165,944
Clays do.	672	33,074	726	43,261	598	39,496
Gem stones	NA	e6	NA	W	NA	W
Peat thousand short tons	243	5,333	365	5,743	363	6,068
Sand and gravel:						
Construction do.	e22,500	e49,500	28,233	67,898	e30,000	e74,900
Industrial do.	2,123	12,642	1,467	14,930	1,884	19,713
Stone (crushed) do.	69,266	287,237	e69,000	e288,200	2r78,992	2350,537
Combined value of lime (1985-86), phosphate rock, rare-earth metal concentrates, staurolite, stone (crushed marl, 1987), titanium concentrates (ilmenite and rutile), zircon concentrates, and values indicated by symbol W	XX	1,007,899	XX	r700,919	XX	665,510
Total	XX	1,561,736	XX	r1,289,863	XX	1,346,237

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain stones; value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Florida in 1986, by county[1]

County	Minerals produced in order of value
Bay	Sand and gravel.
Brevard	Clays, sand and gravel.
Broward	Sand and gravel.
Calhoun	Do.
Clay	Titanium concentrates, zircon concentrates, rutile, sand and gravel, staurolite, clays, peat.
Dade	Cement.
Escambia	Sand and gravel.
Gadsden	Clays, sand and gravel.
Glades	Sand and gravel.
Hamilton	Phosphate rock.
Hardee	Do.
Hendry	Sand and gravel.
Hernando	Cement, clays.
Highlands	Peat.
Hillsborough	Phosphate rock, cement, peat.
Lake	Sand and gravel, peat, clays.
Leon	Sand and gravel.
Madison	Peat.
Manatee	Phosphate rock, cement.
Marion	Clays, sand and gravel.
Palm Beach	Peat.
Polk	Phosphate rock, sand and gravel.
Putnam	Sand and gravel, clays, peat.
St. Lucie	Sand and gravel.
Sarasota	Do.
Sumter	Lime, peat.
Walton	Sand and gravel.
Washington	Do.
Undistributed[2]	Stone (crushed), rare-earth minerals, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—Florida's economy continued to be dominated by trade, service, and construction, with the construction sector a major user of mineral aggregates. The State remained one of the fastest growing in the Southeast, resulting in sustained high levels of output from construction aggregate operations.

The port of Tampa handled over 49 million short tons of cargo in the fiscal year ending September 30, 1987, up from 44 million tons the previous year. Of the cargo handled, nearly 47% was exports and nearly 98% was bulk cargo. Various kinds of bulk phosphate exports totaled 13.8 million tons, down from 14.2 million tons in fiscal year 1986. Mineral imports included cement, clinker, granite, gypsum, potash, salt, and sulfur.

Employment.—Florida's 1987 unemployment rate was 5.3%, down from 5.7% in 1986. All mineral-related sectors shared in this increase of employment. The mining sector increased about 4% while the phosphate industry increased 7%. At a high level for several years, construction increased slightly, while primary metals picked up 4%.

Legislation and Government Programs.—In response to financial problems of the phosphate industry, the Florida Legislature enacted a bill to reduce the severance tax on phosphate rock production. The act reduced the phosphate severance tax from $2.23 to $1.79 per short ton, effective July 1, 1987, with a further reduction to $1.35 per short ton on January 1, 1988, effective for 1 year. After that, the rate will be $1.35 per short ton times an index pegged to phosphate rock production.

The Florida Institute of Phosphate Research funded research on mining and processing of phosphate rock, including reclamation of disturbed lands. Funding was received from severance taxes on phosphate and was directed to beneficiation, chemical processing, and environmental, mining, and reclamation studies. A top priority for research was utilization of phosphogypsum, a byproduct of fertilizer production.

The Florida Department of Revenue reported receipts of severance taxes for solid minerals during fiscal year 1987 of $68.1 million, down from $94.4 million in 1986.

The U.S. Bureau of Mines conducted various research projects of benefit to the phosphate industry. Bureau-developed technologies included a one-stage flotation process to improve phosphate recovery, a technique to dewater phosphate slimes, and a method for recovering sulfur from phosphogypsum waste. In addition, two Reports of Investigations (RI) were also released: RI 9101, "Borehole (Slurry) Mining of Coal, Uraniferous Sandstone, Oil Sands and Phosphate Ore," and RI 9110, "Recovery of Phosphate from Florida Phosphate Slimes."

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Shipments of both masonry and portland cement increased over those of 1986. Cement remained the third-leading commodity by value in Florida. Nationally, output of masonry cement ranked third while that of portland cement ranked seventh. Construction activities have remained at high levels in the State, keeping output at a relatively high level. Although demand was strong, prices remained steady as imports affected the domestic industry. Six companies produced portland cement at six plants. Masonry cement was produced at four plants. Cement and clinker were imported: cement through Miami and Tampa while clinker came only through Tampa. Cement imports totaled 3.6 million short tons compared with 2.5 million tons in 1986; 64% came through Tampa. Clinker imports decreased from 960,000 tons in 1986 to 880,000 tons in 1987. Cement imports came mainly from Mexico, Spain, and Venezuela while clinker came mainly from Mexico and Spain.

Portland cement shipments were predominately in bulk form by truck and rail. Major consumers were ready-mixed concrete contractors, building material dealers, and concrete products manufacturers. In-state raw materials used to manufacture cement included coral, fly ash, limestone, sand, and staurolite. Out-of-State raw materials included gypsum and iron ore. Eight rotary kilns were operated at the six plants. Five were wet process and three were dry process. Energy requirements included 406 million kilowatt-hours of electric energy, an increase over the 379 million kilowatt-hours used in 1986. In addition, other energy raw materials included coal, fuel oil, and natural gas.

Florida Crushed Stone Co. completed performance testing late in the year at its new 600,000-short-ton-per-year cement plant at Brooksville. The cement plant went on-line in February with the powerplant and lime plant scheduled for startup in 1988. General Portland Inc. started utilization of a pneumatic ship-unloading system at its terminal in Tampa. The system was permanently mounted on the dock and was designed to unload bulk carriers up to 39,000 deadweight tons at a capacity of 800 metric tons per hour.

Clays.—Common clay, fuller's earth, and kaolin were produced in Florida. Total clay output decreased by nearly 130,000 short tons while value decreased by $3.8 million. Common clay output and values decreased from those of 1986. Major uses were in the manufacture of cement and lightweight aggregate.

Four companies mined attapulgite fuller's earth at four pits in Brevard, Gadsden, and Marian Counties. Production and value decreased from those of 1986. Florida ranked second nationally in output of fuller's earth. Major uses for fuller's earth were as pet waste, oil and grease absorbents, and in fertilizers, pesticides, and saltwater drilling muds.

Kaolin was produced by one company in Putnam County; output and value increased over that of 1986. Kaolin was used where a high degree of workability was required. Main uses were electrical porcelain, whiteware, and wall tile. Also recovered at the operation was byproduct industrial sand, which was used mainly for glassmaking.

Fluorspar.—Fluosilicic acid was recovered as a byproduct of wet-process phosphoric acid manufacture at six locations. Fluosilicic acid was used to produce cryolite, aluminum fluoride, and sodium silica fluoride, and was also used in water fluoridation.

Peat.—Florida ranked first in the Nation in output of peat. But with sales decreasing slightly, unit values increased. Thirteen operations produced reed-sedge and humus peat in eight counties. Peat was shipped mainly in bulk and used as a potting soil and in nurseries.

Phosphate Rock.—Florida continued to rank first nationally in the production of phosphate rock, and the industry remained the predominant nonfuel industry in the State. Production increased slightly in 1987 after a drop of over 25% in 1986. Output still has not returned to levels attained in the early 1980's. The problems were decreased domestic consumption and a decline in exports, in the face of foreign competition. Employment in phosphate mining increased 7% as the industry picked up late in 1986. Employment remained relatively constant through 1987. To assist the industry in recovery, the State Legislature lowered the severance tax from $2.23 per short ton to $1.79 per ton, effective July 1, 1987. A further reduction to $1.35 per ton

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will be effective on January 1, 1988.

The industry continued to change ownership as Agrico Chemical Co. was purchased by Freeport-McMoRan Resource Partners Ltd. W. R. Grace & Co. was purchased by Seminole Fertilizer. Beker Phosphate Corp. was acquired by Nu-West Industries Inc. Mobil Mining and Minerals Co. completed its purchase of the closed Big Four Mine from FCS Energy Inc., who had purchased it from AMAX Chemical Inc.

With the exception of Beker and Hopewell Land Corp., all the phosphate companies were operating at yearend. The companies produced at less than capacity as periodic shutdowns and reduced schedules kept output in line with demand.

In addition to the companies and mines listed in the following table, three companies recovered soft phosphate rock from hard-rock phosphate mine tailings ponds in north-central Florida. The material was sold as an animal feed supplement.

Land-pebble phosphate was produced by 10 companies at 14 mines as shown in the following tabulation:

Company	Mines	Status	Production	Exports
Agrico Chemical Co	Fort Green	Operated	Increased	Yes.
	Payne Creek	Reopened late in year		
	Saddle Creek	Closed late in year		
Beker Phosphate Corp	Wingate Creek	Closed early in year	Decreased	No.
CF Industries Inc	Hardee Complex No. 1.	Operated	do	No.
Estech Inc	Silver City	do	Increased	Yes.
Gardinier Inc	Fort Meade	do	do	No.
W. R. Grace & Co	Four Corners	Closed	do	Yes.
	Hooker's Prairie	Operated		
International Minerals & Chemical Corp.	Clear Springs	do	Decreased	Yes.
	Haynsworth	Closed		
	Kingsford	Operated		
	Lonesome	Closed; reopen in 1990's.		
	Noralyn	Operated		
Mobil Mining and Minerals Co	Big Four	Closed	Increased	Yes.
	Fort Meade	Operated		
	Nichols	Closed		
Occidental Chemical Co	Suwanee River	Operated	Decreased	Yes.
	Swift Creek	do		
U.S.S. Agri-Chemicals Inc	Rockland	do	do	No.

Sand and Gravel.—Florida produced both construction and industrial sand and gravel during the year. Together they were the fourth-leading commodity in value among nonfuel minerals produced in the State. Total output was estimated to have increased over that of 1986.

Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel production was estimated to have increased over its previous record-high output in 1986. This high level of output was indicated by the sustained level of construction employment during the year.

Industrial.—Six companies produced industrial sand, one as a byproduct of kaolin mining. Output increased substantially, and the State ranked fifth nationally in output of industrial sand. Major markets were in glass manufacture and foundry sands.

Staurolite.—Florida remained the only State with a recorded production of staurolite, an iron-aluminum silicate. Staurolite was recovered as a coproduct of heavy-mineral processing by E. I. du Pont de Nemours & Co. Inc. in Clay County. Staurolite was used in foundry applications, sandblasting, and cement manufacture.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Florida ranked third nationally in the production of total crushed stone, second in shell, and third in limestone. Crushed stone also ranked second in mineral value in Florida with both output and value increasing. Crushed stone was produced by 86 companies at 115 quarries in 25 counties. Continued high levels of construction activi-

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ty resulted in the highest level of output recorded. Florida produced dolomite, limestone, marl, and oyster shell. Uses were mainly in construction and cement manufacture. Some granite was imported through the port of Tampa for specialty uses.

Dravo Basic Materials Co. acquired a 1-million-short-ton-per-year limestone quarry at Perry from Florida Crushed Stone Co. The quarry, near Tallahassee, complements Dravo's other operations at Chattahooche and Pensacola. Dravo also will ship stone from The Bahamas to its new distribution center in Tampa.

Ideal Basic Industries Inc. was developing a limestone quarry in the Dominican Republic with plans to ship the stone to gulf and east coast ports, including Tampa.

M. J. Stavola Industries Inc. acquired Dixie Lime & Stone Co. at Sumterville and Southern Materials Corp. at Lowell. Stavola plans to construct a ground calcium carbonate facility at Lowell.

Vulcan Materials Co. formed a joint venture with Mexico's Grupo ICA to quarry stone in the Yucatán Peninsula to ship to gulf coast markets, Tampa being one of the major markets. Total investment was estimated at $150 million with an initial capacity of 7 million short tons of stone per year. Shipments were expected to begin by late 1988.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the four Florida districts depicted in figure 1.

Districts three and four had the highest production of crushed stone, supplying over 80% of the State's output. Nineteen companies produced over 1 million short tons each and accounted for 31% of the State's production.

Table 3.—Florida: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	53	294
Filter stone	732	3,584
Coarse aggregate, graded:		
Concrete aggregate, coarse	14,980	86,245
Bituminous aggregate, coarse	4,970	25,528
Bituminous surface-treatment aggregate	975	4,522
Fine aggregate (-3/8 inch):		
Stone sand, concrete	6,045	28,073
Stone sand, bituminous mix or seal	2,320	11,403
Screening, undesignated	3,811	16,369
Coarse and fine aggregates:		
Graded road base or subbase	16,907	48,611
Unpaved road surfacing	476	1,474
Crusher run or fill or waste	4,605	10,796
Other construction[2]	2,341	7,458
Agricultural: Agricultural limestone	277	1,735
Chemical and metallurgical: Cement manufacture	1,985	8,002
Special: Other miscellaneous[3]	1,059	8,692
Other unspecified[4]	17,457	87,751
Total	[5]78,992	350,537

[1]Includes limestone, dolomite, shell, and miscellaneous stone; excludes marl.
[2]Includes coarse aggregate (large), macadam, railroad ballast, other fine aggregate, and combined coarse and fine aggregates.
[3]Includes poultry grit and mineral food, other agricultural uses, sulfur oxide removal, mine dusting and acid water treatment, and asphalt fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.

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Table 4.—Florida: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	W	W	--	--	W	W	765	3,643
Coarse aggregate, graded[2]	W	W	W	W	6,678	42,462	13,158	65,292
Fine aggregate (-3/8)[3]	W	W	W	W	1,353	5,417	10,921	50,782
Coarse and fine aggregates[4]	W	W	8,247	25,582	W	W	9,317	24,046
Other construction	67	473	1,213	9,338	5,243	14,430	1,251	2,894
Agricultural[5]	(6)	(6)	(6)	(6)	637	3,445	--	--
Chemical and metallurgical[7]	--	--	(6)	(6)	96	420	(6)	(6)
Special[8]	--	--	(6)	(6)	--	--	--	--
Other miscellaneous	88	399	611	6,582	--	--	1,890	7,582
Other unspecified[9]	1,209	5,286	1,320	5,820	6,908	43,302	8,020	33,343
Total[10]	1,364	6,159	11,392	47,322	20,914	109,475	45,322	187,581

W Withheld to avoid disclosing company proprietary data; included with "Other construction."

[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).

[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.

[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), fine aggregate (screen), and fine aggregate (screening, undesignated).

[4]Includes graded road base or subbase, unpaved road surfacing, crusher run or fill or waste, and combined coarse and fine aggregates.

[5]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.

[6]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[7]Includes cement manufacture and sulfur oxide removal.

[8]Includes mine dusting and asphalt filler.

[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[10]Data may not add to totals shown because of independent rounding.

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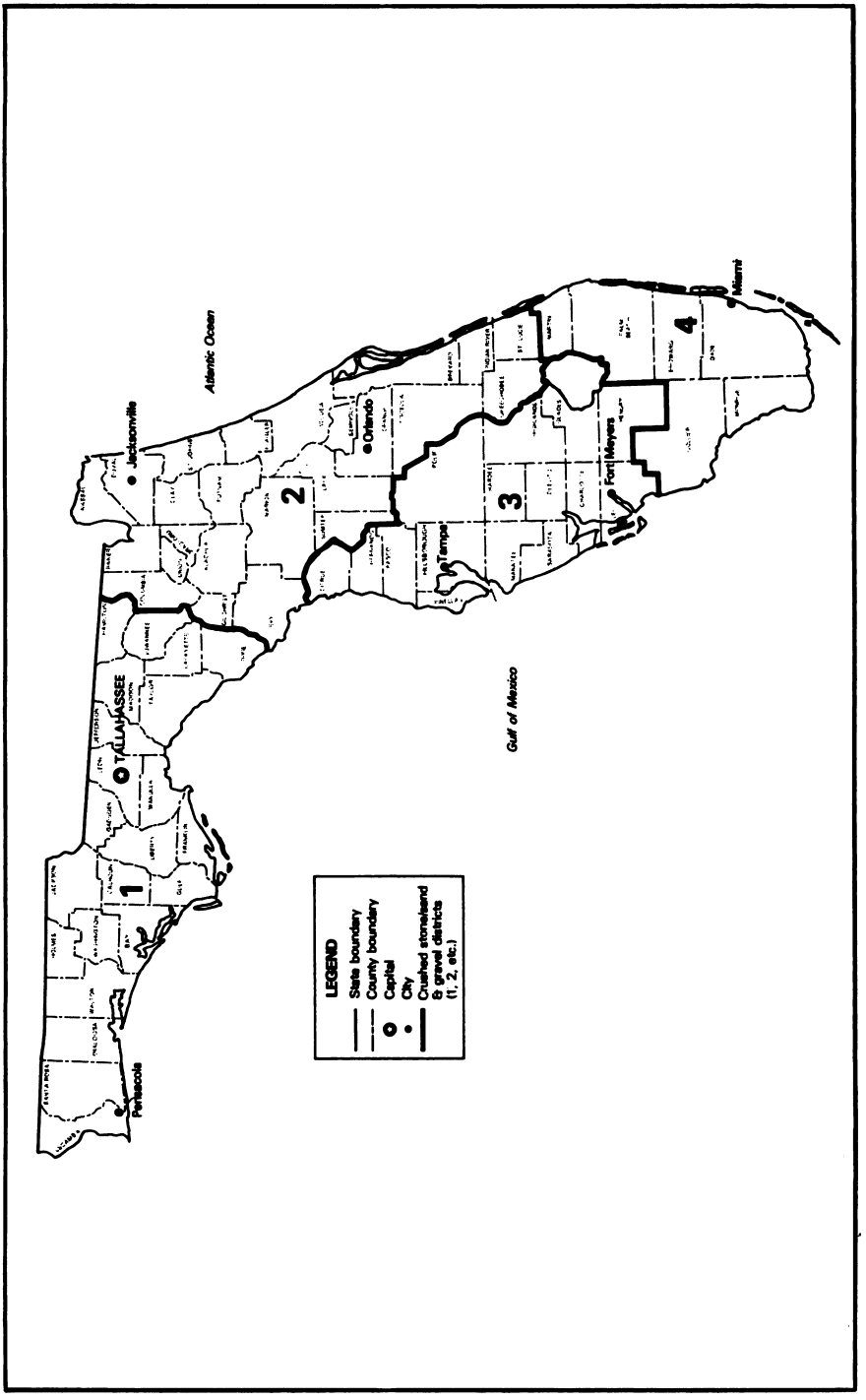

Figure 1.—Aggregate-producing districts in Florida.

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Sulfur (Recovered).—Output from Exxon Corp.'s natural gas desulfurization plants in Santa Rosa County decreased for the ninth straight year as oil and gas production decreased.

Other Industrial Minerals.—Three companies calcined imported gypsum at two plants in Duval County and one in Hillsborough County. USG Corp., Jim Walter Corp., and National Gypsum Co. calcined gypsum for wallboard manufacture. Florida ranked third nationally in output of wallboard. Output of calcined gypsum remained at about the same level as in 1986. USG invested an additional $6 million in an expansion program at its facilities in Jacksonville. Byproduct gypsum was recovered by Occidental Chemical Co. at White Springs. Production decreased slightly while unit values increased. Air Products & Chemicals Inc. produced anhydrous ammonia at its Pace Junction facility; capacity was 100,000 short tons per year. Perlite from out of State was expanded by four companies; production and value decreased. Perlite was expanded at plants in Broward, Duval, Escambia, and Indian River Counties. The material was used for construction aggregate, horticultural purposes, insulation, and filler. Crude vermiculite from out of State was exfoliated by two companies at four plants in Broward, Duval, and Hillsborough Counties. Principal uses were for concrete aggregate, horticulture, and insulation.

METALS

Iron and Steel.—Florida Steel Corp. continued to operate minimills at Jacksonville and Tampa. In January, Florida Steel acquired Knoxville Iron Co. for a reported $50 million. Knoxville Iron produced reinforcing bars and had a capacity of 220,000 short tons per year.

Mineral Sands.—*Rare-Earth Minerals.*—Florida remained the only State with recovery of rare earths from mining mineral sands. Associated Minerals (USA) Ltd. Inc. recovered monazite concentrate as a byproduct of its operation in Clay County. Both output and unit values increased over those of 1986.

Titanium Concentrates.—DuPont and Associated Minerals produced titanium concentrates from their heavy-mineral sands operations in Clay County. Total output decreased. Florida was the only State in which rutile and ilmenite were produced.

Zircon.—DuPont and Associated Minerals recovered zircon concentrates from their operations in Clay County. Florida remained the only State producing zircon, a byproduct of mineral sands operations. Output decreased but still remained at a relatively high level; unit prices increased.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.
[2]State geologist, Florida Bureau of Geology, Tallahassee, FL.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Lafarge Corp	Box 22348 Tampa, FL 33622	Plants	Hillsborough.
Lonestar Florida Pennsuco Inc	Box 122035 Hialeah, FL 33012	Plant	Dade.
Moore McCormack Resources Inc.	Box 23965 Tampa, FL 33630	do	Hernando.
National Portland Cement Co	Route 1 Port Manatee Palmetto, FL 34221	do	Manatee.
Rinker Portland Cement Corp	Drawer K Palm Beach, FL 33416	do	Dade.
Clays:			
Engelhard Corp., Specialty Chemicals Div.	Menlo Park Edison, NJ 08817	Open pit mines and plant.	Brevard.
The Feldspar Corp., EPK Div.[1]	Box 8 Edgar, FL 32049	do	Putnam.
Florida Solite Corp	Box 297 Green Cove Springs, FL 32043	do	Clay.
Floridin Co	Box 187 Berkeley Springs, WV 25411	do	Gadsden.
Mid-Florida Mining Co	Box 68-F Lowell, FL 32663	do	Marion.
Gypsum (calcined):			
Jim Walter Corp	Box 135 Jacksonville, FL 32226	Plant	Duval.
National Gypsum Co	4100 First International Bldg. Dallas, TX 57270	do	Hillsborough.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Duval.

See footnote at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime:			
Dixie Lime & Stone Co.[2]	Drawer 217 Sumterville, FL 33585	Plant	Sumter.
Peat:			
Atlas Peat & Soil Inc	Box 3867 Boynton Beach, FL 33435	Bog	Palm Beach.
Hyponex Corp	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bog	Lake.
TU-CO Peat	9601 Bear Road Sebring, FL 33870	Bog	Highlands.
Perlite (expanded):			
Airlite Processing Corp. of Florida.	Route 2, Box 740 Vero Beach, FL 32960	Plant	Indian River.
Armstrong Cork Co	Box 1991 Pensacola, FL 35289	do	Escambia.
Chemrock Corp	End of Osage St. Nashville, TN 37208	do	Duval.
W. R. Grace & Co.[3]	62 Whittemore Ave. Cambridge, MA 02140	do	Broward.
Phosphate rock:			
Agrico Chemical Co	Box 1110 Mulberry, FL 33860	Open pit mines and plants.	Polk.
AMAX Chemical Inc	402 South Kentucky Ave. Lakeland, FL 33801	Open pit mine and plant.	Hillsborough.
Beker Phosphate Corp	Box 9034 Bradenton, FL 33506	do	Manatee.
Brewster Phosphates	Bradley, FL 33835	Open pit mines and plant.	Hillsborough and Polk.
CF Industries Inc	Box 790 Plant City, FL 33566	Open pit mine and plant.	Hardee.
Estech Inc	Box 208 Bartow, FL 33830	Open pit mines	Polk.
Gardinier Inc	Box 3269 Tampa, FL 33601	Open pit mine and plant.	Do.
W. R. Grace & Co	Box 471 Bartow, FL 33830	Open pit mines and plant.	Do.
International Minerals & Chemical Corp.	Box 867 Bartow, FL 33830	do	Do.
Mobil Mining and Minerals Co	Box 311 Nichols, FL 33863	do	Do.
Occidental Chemical Co	White Springs, FL 32096	do	Hamilton.
USS Agri-Chemicals Inc	Box 867 Fort Meade, FL 33841	Open pit mine and plant.	Polk.
Sand and gravel:			
Florida Rock Industries Inc., Shands & Baker.	Box 4667 Jacksonville, FL 32201	Pits	Clay, Glades, Lake, Marion, Polk, Putnam.
General Development Corp	1111 South Bayshore Dr. Miami, FL 33131	do	Hendry, St. Lucie, Sarasota.
E. R. Jahna Industries Inc., Ortona Sand Co. Div.	102 East Tillman Ave. Lake Wales, FL 33853	do	Glades, Lake, Polk.
Silver Sand Co. of Clermont Inc.	Route 1, Box US1 Clermont, FL 32711	Pit	Lake.
Staurolite:			
Associated Minerals (USA) Ltd. Inc.[4]	Green Cove Springs, FL 32043	Mine and plant	Clay.
E. I. du Pont de Nemours & Co. Inc.[4]	Du Pont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Do.
Stone:			
Florida Crushed Stone Co	Box 317 Leesburg, FL 32748	Quarries	Hernando and Sumter.
Florida Rock Industries Inc	Box 4667 Jacksonville, FL 32201	do	Alachua, Collier, Hernando, Lee, Levy, St. Lucie, Taylor.
Rinker Southeastern Materials Inc.	Box 5230 Hialeah, FL 33014	do	Dade.
Tarmac Florida Inc	Box 8648 Deerfield Beach, FL 33441	Quarry	Do.
Vulcan Materials Co	Box 7497 Birmingham, AL 35253	Quarries	Broward and Dade.

[1]Also construction and industrial sand and gravel.
[2]Also crushed stone.
[3]Also exfoliated vermiculite.
[4]Also titanium concentrates.

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The Mineral Industry of Georgia

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources, for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and Bruce J. O'Connor[2]

The value of Georgia's extractive, nonfuel mineral production totaled $1.2 billion, the second consecutive year that production was valued at more than $1 billion. Production of all major mineral commodities, excluding common clay and feldspar, increased over the levels reported for 1986. Georgia led the Nation in the output of several industrial minerals, including crushed and dimension granite, marble, and kaolin. The State ranked high in the output of barite, common clay, fuller's earth, and iron oxide pigments. Georgia held its fourth place national ranking in industrial mineral production and ranked eighth nationally in total mineral output.

Table 1.—Nonfuel mineral production in Georgia[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	8,671	$575,097	9,827	$669,200	10,455	$756,093
Gem stones	NA	e20	NA	20	NA	20
Sand and gravel:						
Construction thousand short tons	e5,000	e13,400	8,126	23,222	e9,000	e26,900
Industrial do.	571	6,675	W	W	W	W
Stone:						
Crushed do.	52,062	256,588	e56,700	e293,100	60,834	318,903
Dimension do.	183	19,466	e199	e20,678	179	21,683
Talc do.	16	111	9	61	20	286
Combined value of barite, bauxite (1987), cement, feldspar, iron oxide pigments (crude), kyanite (1985-86), mica (scrap), peat, and values indicated by symbol W	XX	74,718	XX	85,174	XX	88,485
Total	XX	946,075	XX	1,091,455	XX	1,212,370

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Georgia in 1986, by county[1]

County	Minerals produced in order of value
Baldwin	Sand and gravel (construction).
Bartow	Barite, iron oxide pigments, clays.
Bibb	Clays, sand and gravel (construction).
Brantley	Sand and gravel.
Carroll	Do.
Chatham	Do.
Cherokee	Do.
Cobb	Do.
Columbia	Clays.
Columbus (city)	Do.
Cook	Sand and gravel (construction), peat.
Crawford	Sand and gravel (construction).
Decatur	Clays, sand and gravel.
Dougherty	Sand and gravel (construction).
Douglas	Clays, sand and gravel (construction).
Effingham	Sand and gravel (construction).
Elbert	Do.
Evans	Do.
Floyd	Clays.
Fulton	Cement, clays, sand and gravel (construction).
Glynn	Sand and gravel (construction).
Greene	Do.
Gwinnett	Do.
Hart	Mica.
Houston	Cement, clays.
Jackson	Sand and gravel (construction).
Jasper	Feldspar.
Jefferson	Clays.
Lee	Sand and gravel (construction).
Long	Do.
Lowndes	Do.
Marion	Do.
Montgomery	Do.
Murray	Talc.
Pike	Sand and gravel (construction).
Richmond	Clays, sand and gravel (construction).
Screven	Peat.
Sumter	Clays, sand and gravel (construction).
Talbot	Sand and gravel (construction).
Taylor	Do.
Thomas	Clays, sand and gravel (construction).
Twiggs	Clays.
Warren	Do.
Washington	Do.
Wheeler	Sand and gravel (construction).
Wilkinson	Clays.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—In 1987, the State's economy continued to expand at a faster pace than the national average, a trend that began in the early part of the 1980's. Construction activity continued at an accelerated pace with approximately 60% of the construction raw materials, clays, cement, construction sand and gravel, and stone marketed in the Atlanta metropolitan statistical area. Construction minerals comprise approximately 34% of the State's mineral output value.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Georgia's mineral output is primarily industrial minerals, and the demand for the State's mineral production remained strong throughout the year. The value of industrial mineral production increased by $121 million, 11% more than that reported in 1986.

Barite.—New Riverside Ochre Co. and Cyprus Industrial Minerals Co. were the two barite producers in Georgia's historic Cartersville barite district. Both companies produced from surface mines and used flotation methods to recover a barite concentrate used largely in fillers and extenders and in manufacturing barium chemicals. The demand for chemical-grade barite remained strong.

Cement.—The State's two cement producers, Blue Circle Inc. and Medusa Cement Co., reported a 9% increase in cement output over the 1986 level. The two companies operated six kilns with a total annual capacity of 1,003,000 short tons of clinker.

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Clays.—Georgia, again, led the Nation in the production of clays, accounting for 23% of the tonnage mined in the United States. The value of the State's clay production increased $87 million over that reported in 1987 because of a vigorous demand for the three clay types mined: kaolin, fuller's earth, and common clay.

Table 3.—Georgia: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Kaolin		Fuller's earth		Common clay	
	Quantity	Value	Quantity	Value	Quantity	Value
1983	5,886	523,407	692	32,826	1,281	3,773
1984	6,508	562,697	569	32,415	1,601	4,918
1985	6,345	534,980	593	34,628	1,733	5,489
1986	6,778	635,220	532	26,322	2,516	7,658
1987	7,424	713,524	591	35,213	2,440	7,356

Table 4.—Georgia: Kaolin sold or used by producers, by county

County	1986			1987		
	Number of mines	Quantity (thousand short tons)	Value (thousands)	Number of mines	Quantity (thousand short tons)	Value (thousands)
Jefferson	1	W	W	1	W	W
Richmond[1]	2	319	$11,547	2	234	$6,719
Twiggs	6	1,267	121,617	6	1,551	155,177
Washington	5	1,675	143,522	5	2,549	235,432
Wilkinson	4	1,499	195,249	4	1,093	130,962
Other[2]	7	2,018	163,285	8	1,996	185,235
Total[3]	83	6,778	635,220	86	7,424	713,524

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes Jefferson County.
[2]Includes Columbia, Houston, Macon, Sumter, and Warren Counties, and data indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 5.—Georgia: Kaolin sold or used by producers, by use

(Short tons)

Use	1986	1987
Domestic:		
Adhesives	50,416	46,779
Chemicals	110,000	150,947
Fiberglass and mineral wool	230,039	273,697
Firebrick, blocks and shapes	65,383	67,645
Floor and wall tile, ceramic	16,868	15,558
Paint	219,990	253,340
Paper coating	2,313,664	2,485,279
Paper filling	1,332,351	1,326,615
Plastics	40,997	48,167
Rubber	51,667	59,382
Sanitary ware	147,065	56,511
Whiteware	21,887	22,732
Other	774,104	1,011,868
Exports	1,404,061	1,605,360
Total	6,778,492	7,423,830

Table 6.—Georgia: Fuller's earth sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind	1985		1986		1987	
	Quantity	Value	Quantity	Value	Quantity	Value
Attapulgite	387	25,333	318	15,657	372	22,770
Montmorillonite	206	9,295	214	10,665	219	12,443
Total	593	34,628	532	26,322	591	35,213

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Production of kaolin was reported from 86 mines in the west-central part of the State. During 1987, a robust resurgence in the demand for paper coating grades of kaolin helped propel kaolin sales to a record high of $713.5 million, $78.3 million more than sales reported in 1986. Paper coating was the principal market for most kaolin producers, and coating grades accounted for approximately 80% of sales.

Both ECC American Inc. and Engelhard Corp. were expanding kaolin production facilities during 1987. ECC's 50-million-ton expansion at the Sandersville facility, which included the construction of a fifth calciner (a fourth calciner was completed in early 1987), was scheduled for mid-1988 completion. The work will result in a 40% increase in production capacity.

Engelhard Corp. began work on an $80 million expansion at its middle Georgia operations at Gordon and McIntyre. The expansion is designed to boost plant output by 300,000 tons per year and was to be completed in 1988.

Georgia Kaolin Co. conducted an exploration program near Fairfax, MN. The company had leased a 1,500- to 2,000-acre tract in 1986.

Georgia ranked second in fuller's earth production; output in 1987 from eight mines increased to 372,000 short tons, 54,000 short tons more than the 1986 level. Attapulgite valued at $23 million accounted for 63% of the output, and montmorillonite valued at $12 million accounted for the remaining 37%. Principal markets included absorbents, paint, joint cement, and salt-water-drilling mud.

Georgia ranked fourth in common clay and shale-phyllite production; clay output, 2.4 million short tons valued at $7.4 million, was reported from 16 mines. This was a 77,000-ton, $302,000 decrease from that of 1986. The drop was due to a slight decrease in the number of housing starts from the record number noted in 1986. Principal markets were for brick, tile, cement, and vitrified pipe manufacture.

Feldspar.—The Feldspar Corp. operated mines in Greene and Jasper Counties to produce both a high potash and soda feldspar ore. Crude ore was shipped to the company's beneficiation plant at Monticello where a concentrate was produced by froth flotation. Output fell 3,000 tons below the 1986 level. Principal sales were to the glass, whiteware, and ceramics industry.

Mica.—Franklin Mineral Products Co. Inc. operated a surface mine and grinding plant in Hart County. The company, a subsidiary of the Mearl Corp., produced a wet-ground product. Crude mica was also shipped to a company plant in Franklin, NC, for wet grinding. Much of the output was used by the parent company to manufacture pearlescent pigments. Both output and value increased over that of 1986.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

The 1987 production increased 4 million tons over the 1986 estimate; this was almost $26 million more than the 1986 value. Continued growth in the nonresidential construction industry in the Atlanta area, other areas of the State, and in contiguous States accounted for the strong demand for stone.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 8 presents end-use data for crushed stone produced in the three Georgia districts depicted in figure 1.

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Table 7.—Georgia: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	289	1,917
Coarse aggregate, graded:		
Concrete aggregate, coarse	8,279	46,286
Bituminous aggregate, coarse	6,226	33,070
Bituminous surface-treatment aggregate	673	3,577
Railroad ballast	2,264	10,223
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	2,640	14,098
Screening, undesignated	1,638	8,185
Coarse and fine aggregates:		
Graded road base or subbase	12,279	62,874
Unpaved road surfacing	W	507
Crusher run or fill or waste	4,280	23,947
Other construction[2]	3,097	18,123
Special: Other miscellaneous[3]	2,991	12,521
Other unspecified[4]	16,180	83,577
Total	60,836	318,905

W Withheld to avoid disclosing company proprietary data; included in "Other construction."
[1]Includes limestone, granite, quartzite, marble, slate, and dolomite.
[2]Includes macadam, filter stone, stone sand, lightweight aggregate, and data indicated by symbol W.
[3]Includes agricultural limestone, cement manufacture, and other fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

Table 8.—Georgia: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	159	827	W	W	W	W
Coarse aggregate, graded[2]	1,639	8,885	8,871	49,688	6,932	34,583
Fine aggregate (-3/8 inch)[3]	766	4,339	W	W	W	W
Coarse and fine aggregates[4]	3,303	17,444	10,138	52,795	3,254	17,089
Other construction[5]	407	4,520	3,719	21,213	2,476	11,423
Agricultural[6]	(7)	(7)	--	--	(7)	(7)
Chemical and metallurgical[8]	(7)	(7)	--	--	(7)	(7)
Special[9]	(7)	(7)	--	--	--	--
Other miscellaneous	1,957	9,522	--	--	1,034	2,999
Other unspecified[10]	8,817	45,415	7,362	38,162	--	--
Total[11]	17,047	90,951	30,090	161,858	13,697	66,095

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill.
[5]Includes lightweight aggregate and data indicated by symbol W.
[6]Includes agricultural limestone.
[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[8]Includes cement manufacture.
[9]Inclues other fillers or extenders.
[10]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[11]Data may not add to totals shown because of independent rounding.

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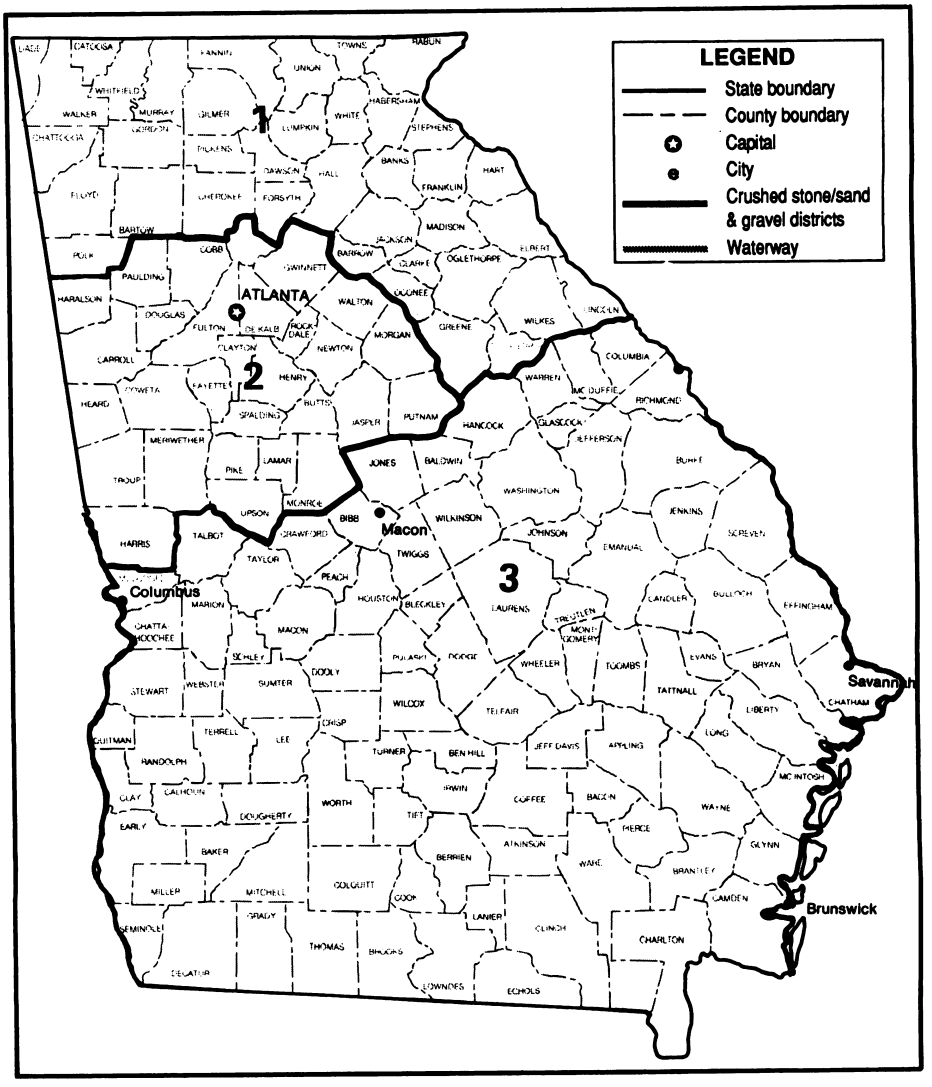

Figure 1.—Aggregate-producing districts in Georgia.

Talc.—United Catalysts Inc., a U.S.-based subsidiary of Süd-Chemie AG of the Federal Republic of Germany, operated the Earnest Mine near Chatsworth in north-central Georgia. Raw talc was trucked to a 40,000-short-ton-per-year mill in Chatsworth for grinding. Ground talc was marketed for use in tile manufacturing asphalt as a dusting, insecticide carrier, and as a plastic and rubber mold release compound.

Other Industrial Minerals.—Crude gypsum was imported into Georgia from Nova Scotia and Newfoundland for gypsum board manufacture. Brunswick Pulp and Paper Co. regenerated lime as part of its papermaking process. During the year, Federal Paperboard Co., Augusta, imported a lime-kiln manufactured by F. L. Smidth and Co.

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in Denmark. Synthetic mullite was produced by the Mulcoa Div. of C-E Minerals Inc. The plant, in Sumter County in the Andersonville bauxite district, sintered a bauxite-kaolin mixture to produce mullite. A Macon firm, Armstrong World Industries Inc., expanded perlite imported from Greece. Major sales were to the insulation industry. Atlantic Steel Co. minimills in Atlanta and Cartersville produced a byproduct slag that was marketed for aggregate applications. Chemical Products Corp., Cartersville, imported strontium ore from Mexico. The crude ore was converted to strontium carbonate for use primarily in the manufacture of television picture tube faceplates.

METALS

Although no metals, other than bauxite and iron oxide pigments, were mined in Georgia, several finished metals were produced from ores, scrap, and concentrate. The following companies were the major metal producers in the State:

Metal	Company	Location
Arsenic	Koppers Co. Inc	Conley.
Copper	Southwire Co	Carrollton.
Iron and steel	Atlantic Steel Co	Atlanta and Cartersville.
Titanium dioxide.	Kemira Oy	Savannah.

New Riverside Ocher mined iron oxide pigments in the Cartersville area of northwest Georgia; Mulcoa, a unit of C-E Minerals, mined bauxite in the Anderson bauxite district in the southwestern part of the State.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

[2]Principal geologist, Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
Cyprus Industrial Minerals Co	Box 130 Cartersville, GA 30120	Open pit mine and mill.	Bartow.
New Riverside Ochre Co.[1]	Box 387 Cartersville, GA 30120	do	Do.
Bauxite:			
Mullite Co. of America	Box 37 Andersonville, GA 31711	do	Macon and Sumter.
Cement:			
Blue Circle Inc	2520 Paul Ave., NW. Atlanta, GA 30318	Plant	Fulton.
Medusa Cement Co	Box 5668 Cleveland, OH 44101	do	Houston.
Clays:			
American Industrial Clay Co	433 North Broad St. Elizabeth, NJ 07207	Open pit mines	Warren and Washington.
Engelhard Corp., Specialty Chemicals Div.	Menlo Park Edison, NJ 08817	do	Decatur, Washington, Wilkinson.
J. M. Huber Corp	Thornall St. Edison, NJ 08817	do	Twiggs and Warren.
Thiele Kaolin Co	Box 1056 Sandersville, GA 31082	do	Warren and Washington.
Feldspar:			
The Feldspar Corp	Box 99 Spruce Pine, NC 28777	Open pit mines and plant.	Greene and Jasper.
Gypsum (calcined):			
Genstar Gypsum Products Co	Box 2580 Irving, TX 75061	Plant	Chatham.
Georgia-Pacific Corp	133 Peachtree St., NE. Atlanta, GA 30303	do	Glynn.
National Gypsum Co	4500 Lincoln Plaza Dallas, TX 75201	do	Chatham.
Mica:			
Franklin Mineral Products Co. Inc	Box 0 Wilmington, MA 01887	do	Hart.

See footnote at end of table.

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Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction (1986):			
Atlanta Sand & Supply Co	Route 1 Roberta, GA 31078	Open pit mine	Crawford.
Brown Bros. Sand Co	Box 82 Howard, GA 31039	Open pit mines	Talbot.
Howard Sand Co	Box 118 Butler, GA 31006	____do____	Talbot and Taylor.
Industrial:			
Montgomery Sand Co., a subsidiary of Florida Crushed Stone Co.	Box 2117 Thomasville, GA 31792	Open pit mine	Thomas.
The Morie Co. Inc	1201 North High St. Millville, NJ 08332	____do____	Marion.
Stone:			
Crushed:			
Florida Rock Industries Inc	Box 4667 Jacksonville, FL 32201	Quarries	Clayton, Fayette, Floyd, Monroe, Spalding.
Georgia Marble Co	Box 409 Lithonia, GA 30058	____do____	De Kalb, Douglas, Forsyth, Gilmer, Hall, Newton, Pickens.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27612	____do____	Jones, Lee, Richmond, Warren.
North Georgia Crushed Stone Co., a division of Koppers Co. Inc.	Box 458 Lithonia, GA 30058	____do____	Clarke, De Kalb, Fayette, Fulton, Habersham, Hall, Stephens, Walker.
Vulcan Materials Co	Box 7497 Birmingham, AL 35253	____do____	Carroll, Cobb, Coweta, Douglas, Fulton, Gwinnett, Henry, Troup.
Dimension:			
Bennie & Harvey Inc	Box 958 Elberton, GA 30635	Quarry and finishing plant.	Oglethorpe.
Coggings Granite Industries Inc	Box 250 Elberton, GA 30635	____do____	Madison.
Granite Panelwall Co., a division of Florida Crushed Stone Co.	Box 898 Elberton, GA 30635	____do____	Elbert.

[1]Also produced crude iron oxide pigments.

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The Mineral Industry of Hawaii

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Department of Land and Natural Resources of the State of Hawaii for collecting information on all nonfuel minerals.

By Fred V. Carrillo[1]

Hawaii's nonfuel mineral production value in 1987 was $73.5 million, an increase of a little more than 4% over that reported in 1986. The rise was attributed to an increase in construction brought about by unusually rapid growth of the visitor industry during 1986 and 1987. Taxable transactions in the construction industry were up by almost one-third and construction earnings reportedly rose 27.1% over those of 1986. Construction-put-in-place amounted to $21 billion for 1987, up 19% from the previous year, according to the Bank of Hawaii.

Industrial minerals accounted for the total mineral value. Cement, lime, pumice, construction sand and gravel, and crushed stone accounted for over 98% of the total value. Hawaii ranked 44th in the Nation in value of minerals produced in 1987.

Trends and Developments.—Research on cobalt-rich manganese crusts slowed as opposition in Hawaii to the program postponed reviews of environmental studies and the proposed regulations for seabed mining. The manganese occurs on seamounts underlying the 200-mile Exclusive Economic Zone surrounding the Hawaiian Archipelago. A draft environmental impact statement for a proposed lease sale was completed in April, naming four possible mining sites off Hawaii. Completion of the final report and issuing of leases was postponed until 1989.

Table 1.—Nonfuel mineral production in Hawaii[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ____ thousand short tons__	7	$588	7	$1,078	10	$1,559
Portland ____ do____	215	16,050	287	24,253	324	26,550
Gem stones____	NA	e25	NA	25	NA	25
Lime ____ thousand short tons__	W	W	3	W	3	W
Sand and gravel (construction) ____ do____	e500	e2,100	605	2,666	e700	e3,500
Stone (crushed) ____ do____	5,627	34,183	e7,100	e42,100	5,732	41,548
Combined value of other industrial minerals and values indicated by symbol W____	XX	326	XX	290	XX	297
Total____	XX	53,272	XX	70,412	XX	73,479

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Hawaii in 1986, by county[1]

County	Minerals produced in order of value
Hawaii	Sand and gravel (construction).
Honolulu	Cement.
Kauai	Sand and gravel (construction).
Maui	Sand and gravel (construction), lime, pumice.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Hawaiian portland cement production and value increased to 323,678 short tons and $26.5 million, and masonry cement production increased to 10,119 short tons and $1.6 million in 1987. Of the total portland cement sold, 73% was used in ready-mixed concrete, 12% by concrete product manufacturers, 7% by building material dealers, 6% by Government agencies and other users, and 2% by highway and other contractors. Lone Star Hawaiian Cement Corp. continued to operate its Barbers Point plant in the Campbell Industrial Park in Honolulu County on Oahu.

Lime.—Hydrated lime was produced by the Hawaiian Commercial & Sugar Co. Ltd. from its calcining operations near Paia, in Maui County. Reported 1987 lime production in Hawaii remained constant in quantity but was up slightly in value from that reported in 1986.

Pumice and Pumicite.—Although 1987 pumice production was slightly higher than that of 1986, value remained constant. Pumice was processed for landscaping usage by Volcanite Ltd. in Hawaii County. Crude pumice for road construction was mined in Maui County by Maui Pineapple Co. Ltd. of Lahaina at its Honokohau cinder pit and in Hawaii County by Puna Sugar Co. Ltd. at Iilewa pit.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Hawaii's construction sand and gravel production was estimated to have increased 16% to 700,000 short tons in 1987.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed stone sold or used by Hawaiian producers in 1987 totaled 5,732,000 short tons valued at $41.5 million. Crushed limestone production used for concrete aggregate, road base and coverings, cement manufacture, construction, and agricultural uses totaled 1,337,000 short tons valued at more than $9 million. Hawaii ranked fifth among the States in the production of volcanic cinder and scoria, reporting 255,000 short tons valued at $1,294,000.

[1]State Mineral Officer, Bureau of Mines, Reno, NV.

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Table 3.—Hawaii: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	78	701
Riprap and jetty stone	30	276
Filter stone	28	341
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,441	9,809
Bituminous aggregate, coarse	208	1,201
Fine aggregate (-3/8 inch):		
Stone sand, concrete	729	9,990
Stone sand, bituminous mix and seal	369	2,316
Screening undesignated	85	410
Coarse and fine aggregates:		
Graded road base or subbase	976	5,852
Unpaved road surfacing	109	441
Crusher run or fill or waste	379	2,372
Other construction[2]	99	733
Chemical and metallurgical, cement manufacture	746	4,252
Special: Other unspecified[3]	456	2,854
Total	[4]5,732	41,548

[1]Includes limestone, traprock, volcanic cinder and scoria, and miscellaneous stone.
[2]Includes agricultural limestone, bituminous surface-treatment aggregate, and combined coarse and fine aggregates.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Lone Star Hawaiian Cement Corp	Barbers Point Plant 220 South King St. Suite 1700 Honolulu, HI 96813	Cement plant	Honolulu.
Lime:			
Hawaiian Commercial & Sugar Co. Ltd.	Box 266 Puunene, HI 96784	Rotary kiln and continuous hydrator.	Maui.
Pumice:			
Maui Pineapple Co. Ltd	Box 445-C Lahaina, HI 96761	Surface mine	Do.
Puna Sugar Co. Ltd	Box 120 Keaau, HI 96749	do	Hawaii.
Volcanite Ltd	Box 3000 Kailua Kona, HI 96740	do	Do.
Sand and gravel (construction):			
Amelco Corp., Maui Concrete	Box 488 Kahului, HI 96732	Plant and pit	Maui.
Kauai Sand & Gravel Inc	4247 Kapaia Rd. Lihue, HI 96766	do	Kauai.
Stone (crushed):			
Ameron Honolulu Construction & Drayage Ltd.	Box 29968 Honolulu, HI 96820	Quarries	Honolulu and Maui.
Grace Pacific Corp., Concrete and Rock Div.	91-920 Farrington Hwy. Ewa Beach, HI 96707	do	Do.
Grove Farm Rock Co. Inc	Puhi Rural Station Lihue, HI 96776	do	Kauai.
Herbert Tanaka Co	87-1748 Farrington Hwy. Waianae, HI 96792	Quarry	Honolulu.
Kuwaye Bros. Inc	160 Keaa St. Hilo, HI 96720	do	Hawaii.
Lone Star Hawaii Rock Products	11555 Dublin Canyon Rd. Pleasanton, CA 94566	do	Honolulu.

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The Mineral Industry of Idaho

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Idaho Geological Survey for collecting information on all nonfuel minerals.

By W. L. Rice[1] and E. H. Bennett[2]

Idaho's nonfuel mineral production value decreased to $270 million in 1987, down slightly from the 1986 total. A significant rise in the value of gold production and lesser increases in the production values for crushed stone, construction sand and gravel, vanadium, and garnet were insufficient to offset decreases in the value of phosphate rock, silver, and molybdenum production.

Table 1.—Nonfuel mineral production in Idaho[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	2	W	2	W	22	$230
Copper (recoverable content of ores, etc.) metric tons	3,551	$5,242	W	W	W	W
Gem stones	NA	e175	NA	$305	NA	50r
Gold (recoverable content of ores, etc.) troy ounces	44,306	14,074	70,440	25,938	97,773	43,79r
Lead (recoverable content of ores, etc.) metric tons	33,707	14,169	9,951	4,836	W	W
Lime thousand short tons	93	5,803	89	4,729	97	5,149
Phosphate rock thousand metric tons	3,784	104,000	r4,235	r82,332	3,411	47,072
Sand and gravel (construction) thousand short tons	e4,000	e11,400	5,708	14,830	e7,200	e28,000
Silver (recoverable content of ores, etc.) thousand troy ounces	18,828	115,645	11,207	61,301	W	W
Stone (crushed) thousand short tons	2,019	6,977	e3,700	e12,700	3,852	15,346
Zinc (recoverable content of ores, etc.) metric tons	W	W	351	294	W	W
Combined value of antimony (1985-86), cement, clays (bentonite, common clay, fire clay, and kaolin (1985-86)), garnet (abrasive), molybdenum, perlite, pumice, sand and gravel (industrial), stone (dimension), vanadium, and values indicated by symbol W	XX	81,181	XX	66,783	XX	129,272
Total	XX	358,666	XX	r274,048	XX	269,373

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Idaho in 1986, by county[1]

County	Minerals produced in order of value
Ada	Sand and gravel.
Bannock	Cement, sand and gravel.
Benewah	Sand and gravel.
Bingham	Phosphate rock, sand and gravel.
Blaine	Sand and gravel.
Bonner	Do.
Bonneville	Sand and gravel, pumice.
Boundary	Sand and gravel.
Canyon	Sand and gravel.
Caribou	Phosphate rock, sand and gravel.
Cassia	Sand and gravel.
Clark	Clays.
Custer	Molybdenum, silver, lead, gold, copper.
Franklin	Sand and gravel.
Fremont	Do.
Gem	Do.
Gooding	Do.
Idaho	Sand and gravel, gold, silver.
Kootenai	Sand and gravel.
Latah	Clays, sand and gravel.
Lincoln	Sand and gravel.
Madison	Do.
Minidoka	Do.
Nez Perce	Do.
Oneida	Pumice, perlite.
Owyhee	Gold, silver, sand and gravel.
Power	Sand and gravel.
Shoshone	Silver, lead, copper, gold, antimony, zinc.
Teton	Sand and gravel.
Twin Falls	Do.
Valley	Gold, silver, sand and gravel.
Washington	Sand and gravel.
Undistributed[2]	Stone, gem stones, vanadium.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Silver was the leading mineral commodity in terms of value, followed by phosphate rock, gold, and molybdenum. The metallic minerals—copper, gold, lead, molybdenum, silver, vanadium, and zinc—accounted for 58% of the State's total nonfuel mineral value for the year, compared with 52% in 1986, and 59% in both 1985 and 1984. Idaho ranked first in the Nation in garnet and vanadium production; second in silver output; third in the production of phosphate rock, molybdenum, and lead; and fourth in pumice production. The State ranked 31st nationally in the value of nonfuel minerals production in 1987; it was 32d in 1986.

Trends and Developments.—Depressed silver prices, persisting through the first quarter of 1987, precluded an early reopening of Idaho silver mines closed during 1986. Beginning the year at $5.44 per troy ounce, silver reached a high of about $9.66 per ounce in late April and averaged $7.01 per ounce for the year. By yearend, three Coeur d'Alene District mines had reopened, although full production was not expected from two of the operations until well into 1988. Two of the reopened mines, which had produced about 25% of new domestic silver in 1985, required a silver price of about $7.00 per ounce to operate profitably. Idaho produced 21% of the Nation's new silver in 1987, compared with nearly 33% in 1986 and almost 48% in 1985.

Idaho's molybdenum production decreased again in 1987, in response to a worldwide oversupply of the metal and a glut of tariff-free, low-cost imports from Chile and Mexico.

Idaho's gold production was up significantly for the second consecutive year. The first full year of production from a major new mine, a full year's output from a past producer reopened in 1986, and sustained full-scale production from a southwestern Idaho gold-silver mine were primary reasons for the increase. Exploration for gold increased in the State during 1987, and several deposits were advanced to the development stage.

Employment.—The reopening of three silver mines and one phosphate operation during the last half of 1987 was insufficient to offset mining personnel cutbacks at Cyprus Minerals Co.'s Thompson Creek molybdenum mine and at other operations, resulting in a second year of decreased employment in Idaho's mineral sector. Metal mining employment declined to 1,600 workers, almost 16% below the 1986 employment figure; overall mining employment fell by nearly 14%, to 2,500 workers. Average weekly earnings in 1987 for Idaho's mineral industry production workers was $608, the highest of all production workers in the State.

According to data supplied by the State of

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Idaho Department of Employment, average weekly wages for mineral industry production workers in the Coeur d'Alene District, Shoshone County, decreased to $492 in 1987, compared with the weekly average wage of $673 paid in 1986. Reflecting the reopening of the silver mines, Shoshone County mining employment increased from 687 workers in January to 943 employees at yearend.

Environmental Issues.—In January, the U.S. Environmental Protection Agency (EPA) released the Bunker Hill Site Remedial Investigation Study Work Plan. The plan covered a phase of the eventual Superfund cleanup of mining-related hazardous wastes in a 21-square-mile area in the Coeur d'Alene District, Shoshone County. The EPA-sponsored study estimated that 36,500 tons of hazardous waste, containing lead, beryllium, cadmium, mercury, arsenic, asbestos, and polychlorinated biphenyls (PCB) remain at the Bunker Hill smelter site near Kellogg. Gulf Resources & Chemical Corp., former owner of the Bunker Hill operation, assumed responsibility for cleanup studies in unpopulated areas of the Superfund site, including the dormant Bunker Hill Mine and smelter complex. The Idaho Department of Health and Welfare, responsible for cleanup studies in populated areas, selected the CH2M Hill engineering firm as contractor for the work. Total cost for the entire cleanup, which would take several more years, was estimated at $50 million.

In April, the Ninth U.S. Circuit Court of Appeals ruled that the State of Idaho could sue past operators of the Blackbird Mine at Cobalt, Lemhi County, for environmental damages to the Panther Creek drainage. The State contended that the mine operators, Noranda Mines Ltd., Noranda Exploration Inc., Hanna Mining Co., and Howmet Turbine Corp., were responsible for mining-related water pollution. Idaho sought up to $25 million for environmental damages.

Exploration Activities.—Mineral exploration increased in Idaho in 1987; gold deposits again were the primary targets. The total number of major mineral exploration programs nearly doubled to 61 from the 38 recorded for 1986. By yearend, 78,469 active mining claims were on file with the U.S. Bureau of Land Management (BLM). Counties with the highest exploration activity were Blaine, Boise, Custer, Idaho, and Shoshone.

Silver exploration in the Coeur d'Alene mining region recovered slightly from the depressed level of 1986. Underground exploration resumed in August at Callahan Mining Corp.'s long-term Caladay Project near Wallace. The new $4 million program called for 2,600 feet of drifting on two levels, and 6,900 feet of underground diamond drilling; Callahan's earlier exploration efforts at the Caladay cost $26.6 million, including $21 million for the shaft and $5.6 million for drifting and drilling. Teck Resources (U.S.) Inc. completed the last phase of a 5,000-foot-deep navi-drill hole to investigate the silver potential of the Blue Jay mineralized zone at the Gem State-Rock Creek claims.

Cominco American Incorporated drilled on claims north of the Golden Chest Mine near Murray, Shoshone County. The Newmont Mining Corp.-TAP Resources Ltd. joint venture began a drilling program in August to investigate a possible low-grade, mass-minable gold deposit on the Golden Chest property. Sundance Mining-Development Corp. conducted a preliminary surface exploration program for gold at the Wake Up Jim property near Murray. Cominco also examined three properties in the St. Joe area, including drilling programs at Granite Peak and Moores Saddle.

In Lemhi County, FMC Gold Co. continued a gold exploration drilling at Ditch Creek and drilled 11 holes on the Freeman Creek property leased from St. Joe Minerals Corp. Canyon Resources Corp. drilled a new prospect on Beartrack Creek north of Leesburg and was to continue evaluation of the site in 1988. Metron Resources drilled on the Porphyry Ridge property south of the Blackbird Mine and shipped 4,600 short tons of ore to Clayton Silver Mines for mill testing. Noranda Exploration examined the old Kittie Burton and Ulysses Mines in the Indian Creek District, and West Fork Gold Mining Co. drilled on the West Fork of Indian Creek. In the Gibbonsville District, Lemhi County, Northwest Mineral Development Corp. trenched and drilled on the Wagonhammer claims, Merger Mines Inc. explored underground at the Cyanide Gulch property, and Eagle Claw Mining Co. completed a 400-foot-long drift at the Clara Morris Mine.

Alotta Resources Ltd. drilled about 75 reverse-circulation holes at the Mineral Zone project north of Elk City, Idaho County. In October, Billiton Exploration USA Inc. joint-ventured into the project. Drilling continued until late in the year. Estimated reserves at the Mineral Zone property were 1.95 million tons grading 0.055 ounce of gold per ton. Silver Crystal Mines Inc. explored

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4,700 acres of claims surrounding the Umatilla Mine west of Orogrande; the property was being explored for gold and platinum. Summit Silver Inc. continued work at the Kimberly Mine in the Marshall Lakes District, and E & E Exploration drilled on an extensive claim block in the Florence Basin, Idaho County.

Meridian Minerals Co. continued a gold exploration program at Middle Mountain, south of Oakley, Cassia County, with efforts centered on volcanic rocks in the Cold Creek Zone and on a fossil sinter in the Blue Hill Zone. Antilles Resources (Exvenco) drilled a gold target in Robber's Gulch, and American Copper & Nickel Co. Inc. drilled on a large claim block south of Antilles' holdings.

GEXA Gold Corp. (Galli Exploration) continued drilling for precious metals in Hardscrabble Gulch, Rocky Bar District, Elmore County. Richweld Resources Ltd. completed diamond drilling at the Blackstone Mine, and discovered new mineralized zones outside the old open pit. J & D Lode and Placer sank an inclined shaft at the Competence Mine in the Neal District; the company was exploring for an extension of known mineralized shear zones.

Billiton Exploration drilled a gold exploration target in the Illinois shear zone in the Gambrinius District and Frontino Corp. continued an exploration program at the Ophir Mine near Idaho City, Boise County. The old Lincoln Mine in the Pearl-Horseshoe Bend District was leased by Union-Eagle Resources Inc.; the company was negotiating with Morrison-Knudsen Co. Inc. for a feasibility study.

Chevron Resources Co. drilled for gold on claims north of the Craters of the Moon National Monument, Butte County, and Cominco explored in Long Canyon north of the Chevron property. Oglebay Norton Co. drilled for base and precious metals on Elkhorn Mountain, Oneida County.

Meridian Minerals continued drilling in the Mink Creek-Scout Mountain area south of Pocatello, and Freeport-McMoRan Gold Co. drilled on an epithermal gold target at Malad Summit, Bannock County.

Chevron drilled nine holes at the Thirsty Mountain gold-mercury prospect near Haystack Peak north of Weiser, Washington County. War Eagle Mining Co. drilled on a large landholding near Silver City, Owyhee County, where the company controls many of the old silver mines.

An exploration program at Rothchild Corp.'s Vienna Mine was successful, and mining was scheduled to begin in the spring of 1988; the ore will be processed at Rothchild's mill near Ketchum, Blaine County. Yanke Machine Shop Inc. explored underground at the Greyhound Mine, Custer County, and ran test batches from a new precious-metals ore shoot through the Greyhound mill.

Amselco Exploration Inc. drilled 44 holes and expanded a claim block at the Golden Gate tungsten mine south of Yellowpine, Valley County. Amselco was exploring the area for precious metals targets. High County Mining Corp. drilled the KT and DC claims on Quartz Creek near Elk Summit, north of Yellowpine.

In the Pend Oreille silver-lead district, Bonner County, the Iron Mask Mining Co. explored underground by crosscutting, raising, and diamond drilling. Shoshone Silver Mining Co. drove a 500-foot-long exploration tunnel at the Idaho Lakeview claims, and Merger Mines explored by drifting at the Cedar Mountain property.

Legislation and Government Programs.—The first regular session of the 49th Idaho State Legislature passed legislation authorizing regulation of the use of cyanide in precious metals recovery. Near yearend, the Idaho Division of Environment, Department of Health and Welfare, completed work on rules and regulations for ore processing by cyanidation. These rules were the first in the Western States to establish engineering, operating, water-quality monitoring, and reclamation standards for precious metals cyanidation, especially in heap leaching. Compiled by a coalition of representatives from the Idaho Mining Association, the Idaho Division of Environment, the Idaho Conservation League, and the EPA, the pioneering rules became effective January 1, 1988.

An Idaho wilderness bill, introduced in Congress in March, called for the addition of 3.9 million acres to the State's existing 3.8 million acres of wilderness. The bill was not enacted. In late December, Idaho's Governor and a member of the State's congressional delegation proposed the addition of 1.3 to 1.4 million acres as official wilderness and the placing of another 300,000 acres in special management units. This legislation was to be introduced into the Senate in early 1988.

The Mining and Mineral Resources Institute of the University of Idaho received $225,000 from the U.S. Bureau of Mines in

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1987; the institute has received a total of nearly $2.73 million from the Bureau since inception of the program in 1978. During the year, the University of Idaho assisted the Virginia Polytechnic Institute in work on mine systems design and ground control.

The U.S. Department of Energy's Idaho National Engineering Laboratory received $3.8 million from the U.S. Bureau of Mines to continue a multiyear extractive metallurgy and materials technology research and development program on strategic and critical minerals.

Idaho received nearly $1.42 million from BLM in 1987 from receipts collected under the Mineral Leasing Act.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Antimony.—Idaho was the only State reporting domestic antimony production in 1987. American Independence Mines & Minerals Co. reported a small amount of antimony production from the Antimony Rainbow Mine, Valley County. The Sunshine Mine, normally the top domestic producer of antimony as byproduct from silver production, was shut down for the entire year.

Copper.—In 1987, production of copper, predominently a byproduct from silver recovery in the Coeur d'Alene District, decreased slightly in quantity but increased in value from that of 1986. Production was reported from five mines in 1987; the largest producers were the Galena, Coeur, and Lucky Friday Mines, which accounted for more than 99% of the total State copper output. Additional small production was reported from Adams and Custer Counties.

Gold.—Gold production in Idaho increased by approximately 39% in quantity and by almost 70% in value from the 1986 levels. Production was recorded from 10 lode mines during the year, unchanged from that of 1986. Pioneer Metals Corp.'s seasonal Stibnite Mine, Valley County, again was the State's first-ranked producer. The company's annual report lists 1987 production from the open pit, heap-leach operation at approximately 36,500 troy ounces of gold and 22,400 troy ounces of silver from oxidized ore.

Production from Pioneer's West End pit ended in 1987; subsequent production will be from the Garnet Creek and Southwest Extension ore bodies. Since startup in 1982, the Stibnite Mine has produced approximately 128,500 ounces of gold and 67,400 ounces of silver. Drilling in 1987 confirmed the existence of additional minable oxide reserves adjacent to existing workings. The potential of sulfide ore underlying the oxide ore bodies was being evaluated; approximately 30,000 tons of sulfide material grading 0.1 ounce of gold per ton was stockpiled and sampled for metallugical testing.

NERCO Minerals Co.'s DeLamar gold-silver mine, Owyhee County, was the second-ranked producer. According to the company's annual 10K report, 1987 production from the open pit, vat-leach operation amounted to 30,000 ounces of gold and 1,733,000 ounces of silver. The North DeLamar pit was largely mined out in 1987; subsequent production will come from the Sommercamp and Glen Silver pits. During the year, a $2.5 million Merrill Crowe-process heap-leach plant was constructed to treat 2 to 3 million tons of stockpiled low-grade ore, plus an additional 1 million tons of mined low-grade material per year for 7 years.

Coeur d'Alene Mines completed the first full season of production at the Thunder Mountain Mine, Valley County. The $18.7 million open pit heap-leach operation, sited at an elevation of about 8,500 feet, is limited to a 6-month operating season, from May through October. The company reported that it exceeded its first full-season production goal of 25,000 ounces of gold with 27,250 ounces of gold and 31,840 ounces of silver. A 1987 exploration program revealed 73,100 tons of new proven and probable ore in the adjacent Lightning Peak area. The proven ore, totaling 650,000 tons grading 0.041 ounce of gold per ton, should extend the mine's life by 2 years.

Other Idaho gold projects advancing to the development or construction stage during 1987 included Geodome Resources Ltd.'s Sunbeam Mine, Custer County; Hecla Mining Co.'s heap-leach project on the Homestake property, Valley County; the joint venture by Glamis Gold Inc., Amir Mines Ltd., and Normine Resources Ltd. at Buffalo Gulch, Idaho County; Canyon Resources (merged with Nevex Gold Inc.) heap-leach operation at the Robinson Dyke deposit, Idaho County; Atlanta Gold Co.'s

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major drilling program at a proposed open pit operation, Elmore County; Ican Minerals Ltd. at the old Idaho Almaden mercury property, Washington County; Atlantis Mining Co.'s Atlantis Mine, Blaine County; and Noranda Exploration's Black Pine cyanide leach project, Cassia County.

Lead.—Idaho ranked third in the Nation in lead production for 1987, although the quantity produced was a small fraction of the national total. Idaho's lead production, a byproduct of silver mining, reflected the continued slump in silver production. Three mines reported lead production in 1987; the bulk came from the Lucky Friday Mine, Shoshone County.

Molybdenum.—Reflecting the stagnant condition of the worldwide molybdenum market, Idaho's 1987 production dropped slightly. The State retained its third ranking nationally in production of the metal. Production at Cyprus Minerals' Thompson Creek Mine, near Clayton, Custer County, was scaled back. The Bonneville Power Administration's low-rate program to help economically distressed industrial users was expected to be of long-term benefit to Thompson Creek.

Rare Earths.—Attention was drawn in 1987 to rare-earth-bearing black sand placer deposits in Boise, Custer, and Valley Counties, central Idaho. A U.S. Geological Survey open file report, based on drilling data generated by the U.S. Bureau of Mines in the 1950's, stated that 23 identified rare-earth deposits contain more than 540,000 short tons of monazite with lesser quantities of euxenite, and 5.2 million tons of ilmenite. The monazite and euxenite carry lanthanum and yttrium, currently used in superconductor research. The placer minerals would have to be recovered by dredging, however, and many of the deposits are in environmentally sensitive areas.

Silver.—Idaho's silver production decreased in both volume and value compared with that of 1986. The State lost its dominant position in domestic silver production, slipping behind Nevada. The revival of silver prices in 1987 did not lead to an immediate restarting of Idaho silver mines closed in 1986. Three mines in the Coeur d'Alene District, accounted for nearly 78% of total State output reported from 10 mines.

ASARCO Incorporated's Galena Mine, near Wallace, was the Nation's third-ranked silver producer in 1987, while the company's nearby Coeur Mine ranked sixth. Production from the Galena Mine decreased from the 1986 level, according to Asarco's annual report, to about 3.3 million ounces of silver and 1,000 tons of copper.

Production at Asarco's Coeur Mine also decreased in 1987, to about 2.5 million ounces of silver and 1,100 tons of copper. Hecla's Lucky Friday Mine, at Mullan, resumed production in June, after a 10-month closure. The company reported production of 667,000 ounces of silver and 4,500 tons of lead in 1987. The new Lucky Friday underhand longwall mining method, developed jointly by Hecla and the U.S. Bureau of Mines, was implemented on the 5300 level. The method utilized mechanized equipment, a ramp system, and cemented sand fill to prevent rock bursts and to lower mining costs. A new 3-year labor agreement was reached in late July, calling for a 15% reduction in wages and benefits. Further wage reductions become effective in the second year of the contract in return for worker participation in a profit-sharing program. Sunshine Mining Co.'s Sunshine Mine on Big Creek, shut down in mid-April 1986 owing to depressed silver prices, began to reopen in December. The Crescent Mine, also on Big Creek and owned by the Bunker Limited Partnership, reopened for exploration and development work in October. In early July, Callahan reactivated its Caladay Project adjacent to the Galena Mine. Expenditure for the second phase of the underground exploration program was projected to be $4 million over the next 20 months; plans included approximately 2,600 feet of drifting and 6,900 feet of diamond drilling.

Vanadium.—Vanadium production in Idaho increased nearly 4% in quantity and almost 27% in value; the State ranked first nationally in the production of vanadium in 1987. Kerr-McGee Chemical Corp. expanded its Soda Springs vanadium recovery plant, Caribou County, during the last half of the year. The operation recovered vanadium from ferrophosphorus slag generated during the production of elemental phosphorus. The expanded plant produced potassium vanadinate used as a catalyst in sulfuric acid manufacture, a super-pure vanadium compound used in alloying high-strength metals, and material used in making maleic hydride.

Zinc.—Zinc production in the State, which was byproduct of silver mining in 1987, increased substantially in both quantity and value from that reported in 1986. The sole zinc producer was the Lucky Friday Mine.

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INDUSTRIAL MINERALS

Cement.—Idaho's cement production decreased slightly in 1987. Ash Grove Cement West, at Inkom, Bannock County, was the State's only cement producer. Most of the cement produced was general use, moderate heat Types I and II gray portland cement; lesser quantities of Type III high-early-strength portland cement and masonry cement also were produced. Finished portland cement was used by ready-mixed concrete companies, 70%; other contractors, 11%; highway contractors, 5%; and building material dealers, miscellaneous customers, and government agencies, 4%.

Clays.—Bentonite, common clay, and kaolin were mined from five pits in Clark and Latah Counties; the clays were used in the manufacture of common brick, fire brick, and in refractory grogs. Production increased about 6% in quantity and by 11% in value.

Diatomite.—American Diatomite Co. began development on deposits of freshwater diatomite north of Bliss, Gooding County. The company planned to mine 75,000 short tons of diatomite during the first year of operation; mining could extend into the 1990's and expand from the current 5 acres to 25 acres.

Garnet.—Idaho ranked first in the Nation in garnet production. The Emerald Creek Garnet Milling Co. at Fernwood, Benewah County, operated at capacity during 1987. The company operated dragline-fed dredge-washing plants on Emerald and Carpenter Creeks; the garnet was recovered by jigging and trucked to the Fernwood plant for drying, crushing, sizing, and packaging. Emerald Creek Garnet was the largest domestic producer of garnet. The product was sold for abrasives, as a filtration medium, for sandblasting, and as the cutting medium for high-pressure water-garnet steel cutting. About 25% of the company's sales were to foreign customers.

Gem Stones.—The value of 1987 gem stone production in Idaho increased to $507,000, compared with the $305,000 total for 1986; the State ranked seventh nationally in the value of its gem stone production. Precious opals, jasper, aquamarine, topaz, gem quartz, and gem garnets were mined in the State.

Lime.—Amalgamated Sugar Co.'s three lime plants in Canyon, Minidoka, and Twin Falls Counties accounted for all of the State's 1987 lime production. Quicklime production for sugar manufacture was up nearly 9% in both quantity and value from that of 1986.

Perlite.—Oglebay Norton Co. purchased the Oneida Perlite Corp. operation in 1987. The company mined perlite from a deposit on Wrights Creek; the material was processed at the Malad City plant, Oneida County. The expanded product was used for industrial fillers, in fireproofing, and as a filtering medium. Much of the Wrights Creek area is underlain by perlite deposits; during the year, the U.S. Forest Service reopened an 80-acre tract previously closed to mineral entry.

Phosphate Rock.—Idaho retained its third rank nationally in marketable phosphate rock production, although the output decreased by about 19% in quantity and 43% in value from the 1986 levels. A decline in both domestic and export selling prices, a generally depressed market for agricultural products and phosphate fertilizers, and the shutdown for most of the year of a major Idaho fertilizer producer and reduced production of another, accounted for the reductions in quantity and value of production. Five open pit phosphate mines in Bingham and Caribou Counties were operated in 1987. Uses for Idaho phosphate were wet-process phosphoric acid, elemental phosphorus, and normal superphosphate.

NuWest Industries Inc. purchased the bankrupt Beker Industries Corp. Conda phosphate fertilizer facility in July. The $50 million purchase price secured the fertilizer plant and a 50% interest in the Conda Partnership mining rights. The operation was restarted in August and operated at 50% to 70% of capacity for the remainder of 1987.

The J. R. Simplot Co. operated the Smoky Canyon Mine at a reduced rate, and also produced phosphate rock from the Gay Mine on the Fort Hall Indian Reservation. Simplot completed work on a 15-year, $30 million program to reduce sulfur dioxide emissions from its Pocatello phosphate fertilizer complex. Monsanto Co. mined phosphate rock at the Henry Mine and operated its Soda Springs elemental phosphorus plant at capacity in 1987. The company completed installation of stack scrubbers at the plant, finishing a $12 million pollution control program.

FMC Corp. completed the second year of a $13 million program to control emissions at its Pocatello elemental phosphorus plant. Stauffer Chemical Co. mined phosphate rock from the Wooley Valley Mine, north-

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east of Soda Springs, for shipment to its elemental phosphorus plant at Silver Bow, MT.

Pumice.—Idaho remained fourth nationally in the production of pumice. Output in 1987 increased in quantity by nearly 38%, and in value by almost 20%. Two operations in Bonneville County and one in Oneida County accounted for the State's output. Hess Pumice Products, Idaho's largest pumice producer, operated its mine on Wrights Creek near Malad City, Oneida County. The company, a major national producer of ground pumice products, sold processed pumice for abrasives in soap and cleaners, for industrial abrasives, and for aggregate in lightweight building blocks. The second-largest producer was Producers Pumice, from the Rock Hollow Mine near Ammon, Bonneville County.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987, and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Estimated 1987 construction sand and gravel production increased approximately 26% in quantity and almost doubled in value from that reported in 1986. Increased activity in highway and secondary road construction and maintenance contributed significantly to the increase.

Industrial.—Industrial sand production in Idaho increased slightly in quantity and decreased a small amount in value from that of 1986. Unimin Corp. produced industrial sand and gravel at the Emmett operation, Gem County. Industrial sand was used in glass containers, for sandblasting, as a filtration medium, in fiberglass manufacture, for roofing granules, and for other applications.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—The 1987 output of crushed stone in Idaho increased by 4% in quantity and by about 21% in value from the levels estimated in 1986, and nearly doubled in value from the level reported in 1985. Six counties—Benewah, Caribou, Fremont, Idaho, Latah, and Nez Perce—accounted for 83% of the State total. Idaho, Caribou, and Bannock Counties were the leading producers.

Table 3.—Idaho: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	16	47
Filter stone	3	12
Other coarse aggregate	11	11
Fine aggregate (-3/8 inch): Screening, undesignated	12	24
Coarse and fine aggregates:		
Graded road base or subbase	1,807	5,790
Unpaved road surfacing	393	1,556
Other construction materials[2]	476	1,761
Agricultural:		
Poultry grit and mineral food	4	11
Other agricultural uses	21	63
Chemical and metallurgical:		
Chemical stone	(3)	(3)
Sulfur oxide removal	(3)	(3)
Refractory stone (including gannister)	25	70
Special:		
Roofing granules	(3)	(3)
Other miscellaneous[4]	533	3,025
Other unspecified[5]	551	2,974
Total	3,852	[6]15,346

[1]Includes limestone, dolomite, granite, sandstone, quartzite, and traprock.
[2]Includes concrete aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, stone sand (concrete), stone (bituminous mix or seal), and crusher run or fill or waste.
[3]Less than 1/2 unit.
[4]Includes cement manufacture and flux stone.
[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[6]Data do not add to total shown because of independent rounding.

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Lava Flow Productions Inc. operated a scoria specialty products quarry near Mountain Home, Elmore County. The scoria was processed and either sold in bulk to landscape nurseries or rescreened and sorted for Lava Flow's specialty markets, which included barbecue rock, aquarium stone, roofing products, potting mixes, and roadbeds for model railroads.

Dimension.—Dimension stone output was up by nearly 63%, but the value decreased by nearly 75% from that of 1986. Quartzite was quarried by Northern Stone Supply Inc. near Oakley, Cassia County, for flagstone and decorative stone.

[1]State Mineral Officer, Bureau of Mines, Spokane, WA.
[2]Associate director, Idaho Geological Survey, Moscow, ID.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement West Inc	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Surface mine and plant.	Bannock.
Clays:			
Clayburn Industries Ltd	3202 Beta Burnaby, BC, Canada	Surface mine	Latah.
A. P. Green Refractories Co., a subsidiary of USG Corp.	Box 158 Troy, ID 83871	do	Do.
Interpace Corp	3502 Breakwater Court Hayward, CA 94545	do	Benewah.
Copper:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mines and mills	Shoshone.
Hecla Mining Co	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Do.
Garnet:			
Emerald Creek Garnet Milling Co. Inc	Route 4, Box 190 Fernwood, ID 83830	Pits and plant	Benewah.
Gold:			
Coeur d'Alene Mines Corp	505 Front Ave. Box 1 Coeur d'Alene, ID 83814	Surface mine and leach plant.	Valley.
Hecla Mining Co	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Shoshone.
NERCO Minerals Co	111 SW. Columbia Portland, OR 97201	Surface mine, mill, leach plant.	Owyhee.
Pioneer Metals Corp	228 South Cole Rd. Boise, ID 83709-0934	Surface mine and leach plant.	Valley.
Lead:			
Hecla Mining Co	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Shoshone.
Lime:			
Amalgamated Sugar Co	First Security Bank Bldg. Ogden, UT 84402	Plants	Various.
Molybdenum:			
Cyprus Minerals Co	7200 South Alton Way Englewood, CO 80110	Surface mine and mill.	Custer.
Perlite:			
Oglebay Norton Co	520 North Michigan Ave. Chicago, IL 60611	Surface mine and plant.	Oneida.
Phosphate rock:			
Conda Partnership	Box 37 Conda, ID 83230	do	Caribou.
Monsanto Co	Box 816 Soda Springs, ID 83276	Surface mine	Do.
J. R. Simplot Co	Box 912 Pocatello, ID 83201	Surface mines and plant.	Bingham and Caribou.
Stauffer Chemical Co	Box 160 Montpelier, ID 83254	Surface mine	Caribou.
Pumice:			
Hess Pumice Products	Box 209 Malad City, ID 83252	Quarry and plant	Oneida.
Producers Pumice	6001 Fairview Ave. Boise, ID 83704	Quarry	Bonneville.
Sand and gravel (industrial):			
Unimin Corp	258 Elm St. New Canaan, CT 06840	Pit	Gem.

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Table 4.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Silver:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mines and mills	Shoshone.
Hecla Mining Co	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Do.
NERCO Minerals Co	111 SW. Columbia Portland, OR 97201	Surface mine, mill, leach plant.	Owyhee.
Sunshine Mining Co	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, refinery.	Shoshone.
Stone:			
Crushed:			
Ash Grove Cement West Inc	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Quarry	Bannock.
DeAtley Co	Box 648 Lewiston, ID 83501	Quarries	Nez Perce.
Monsanto Co	Box 816 Soda Springs, ID 83276	Quarry	Caribou.
Seubert Excavators Inc	Box 57 Cottonwood, ID 83522	Quarries	Idaho.
U.S. Forest Service, Region 4	324 25th St. Ogden, UT 84401	____do	Various.
Dimension:			
Northern Stone Supply Inc	Box 249 Oakley, ID 83346	Quarry	Cassia.
Vanadium:			
Kerr-McGee Chemical Corp	Box 478 Soda Springs, ID 83276	Plant	Caribou.
Zinc:			
Hecla Mining Co	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Shoshone.

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The Mineral Industry of Illinois

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey Division, Illinois Department of Energy and Natural Resources, for collecting information on all nonfuel minerals.

By James J. Hill[1]

Nonfuel mineral production in Illinois was valued at $517.2 million in 1987, a 10% increase over that of 1986. Nationally, the State ranked 17th in value of nonfuel mineral production. Illinois led the Nation in production of fluorspar, industrial sand, and tripoli. Crushed stone continued to be the State's leading nonfuel mineral commodity in terms of value, followed by construction sand and gravel, portland cement, industrial sand, and lime. Production declined for common clays, fluorspar, dimension stone, tripoli, and the byproducts of fluorspar—copper lead, and zinc. Output increased for all other commodities except gem stones, the value of which was estimated to have remained the same as in 1986.

Table 1.—Nonfuel mineral production in Illinois[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) thousand short tons	2,101	$86,211	2,118	$83,783	2,119	$86,210
Clays[2] do.	265	876	283	1,092	233	977
Gem stones	NA	e15	NA	15	NA	15
Sand and gravel:						
Construction thousand short tons	e26,600	e77,000	27,867	82,523	e28,300	e93,300
Industrial do.	4,056	56,915	4,039	52,133	4,346	45,547
Stone:						
Crushed do.	41,044	164,117	e44,200	e179,600	52,102	216,212
Dimension do.	2	107	e2	e107	W	W
Combined value of barite (1985), cement (masonry), clays (fuller's earth), copper, fluorspar, lead, lime, peat, silver, tripoli, zinc, and value indicated by symbol W	XX	74,679	XX	70,272	XX	74,945
Total	XX	459,920	XX	469,525	XX	517,206

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Illinois in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel (construction).
Alexander	Sand (industrial), tripoli.
Bond	Sand and gravel (construction), clays.
Boone	Sand and gravel (construction).
Bureau	Do.
Champaign	Do.
Clark	Do.
Clinton	Do.
Coles	Do.
Cook	Lime, sand and gravel (construction), peat.
Crawford	Sand and gravel (construction).
Cumberland	Do.
De Kalb	Do.
De Witt	Do.
Du Page	Do.
Effingham	Do.
Fayette	Do.
Ford	Do.
Fulton	Do.
Gallatin	Do.
Grundy	Do.
Hardin	Fluorspar, zinc, lead, copper, silver.
Henderson	Sand and gravel (construction).
Henry	Do.
Jackson	Do.
Jo Daviess	Do.
Kane	Sand and gravel (construction), clays.
Kankakee	Sand and gravel (construction).
Kendall	Do.
Knox	Sand and gravel (construction), peat.
Lake	Sand (industrial), cement, sand and gravel (construction), clays.
La Salle	Sand and gravel (contruction).
Lawrence	Cement.
Lee	Clays, sand and gravel (construction).
Livingston	Sand and gravel (construction).
Logan	Do.
McHenry	Do.
McLean	Do.
Macon	Do.
Madison	Do.
Marshall	Sand (industrial), sand and gravel (construction).
Mason	Cement, sand and gravel (construction).
Massac	Sand and gravel (construction).
Moultrie	Sand (industrial).
Ogle	Sand and gravel (construction).
Peoria	Do.
Piatt	Do.
Pike	Clays, sand and gravel (construction).
Pulaski	Sand and gravel (construction).
Putnam	Do.
Randolph	Do.
Rock Island	Do.
St. Clair	Do.
Sangamon	Do.
Schuyler	Do.
Stephenson	Do.
Tazewell	Do.
Vermilion	Do.
Wabash	Do.
White	Peat, sand and gravel (construction).
Whiteside	Sand and gravel (construction).
Will	Do.
Winnebago	Do.
Woodford	Stone (crushed and dimension), gem stones.
Undistributed[2]	

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Employment.—The Illinois Department of Economic Security reported the State's total civilian work force averaged nearly 5.8 million in 1987. Unemployment in the State averaged 7.4%. Employment in mining and quarrying, which included coal mining and oil and gas extraction, totaled 23,900 persons, down about 4% from employment in 1986. Wages averaged $15.44 per hour, and workers averaged 39.3 hours per work week. Employment in the basic steel industry averaged 24,200 persons, a drop of about 4% when compared with that of 1986. Wages averaged $13.72 per hour, and steelworkers put in 44.4 hours in an average work week.

Several work stoppages were reported during 1987. The longest strike (6 months), involving 750 workers at USX Corp.'s South Works plant in Chicago, ended January 31,

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1987. Contract agreements were reached with workers at Bethlehem Rebar Industries in Bedford Park, a manufacturer of reinforcing bars, and Pittsburgh International in Fairbury, a manufacturer of welded steel and drawn tubing. Strikes also were resolved at the John Deere foundry in East Moline and the John Westwick foundry in Galena. In the industrial minerals sector, union workers ratified new contracts at the Livingston Stone Co. and the Vulcan Materials Co. operations in Pontiac, ending a 26-day walkout.

Exploration Activities.—According to the Illinois State Geological Survey (ISGS), exploration for nonfuel minerals was slow during the year. Some interest was expressed in resources of construction aggregate and high calcium limestone in the central part of the State. Ozark-Mahoning Co. operated two diamond-drilling units in connection with further development of its Annabel Lee fluorspar mine in Hardin County. Also, Tammsco and Illinois Minerals Co. operated drill rigs in the Southern Illinois tripoli district in Alexander County. Illinois Minerals Co. sought permits to explore 6,000 acres within the Shawnee National Forest for tripoli deposits.[2]

Legislation and Government Programs.—Two mineral-related bills were enacted into law during 1987. Public Act 289 designated November 13 of each year as a Coal Miners Memorial Day to be observed throughout the State in remembrance of coal miners who gave their lives while working in the mines. Public Act 292 increased the limits of loans obtained from public funds to industry for projects utilizing Illinois coal under the State's Industrial Coal Utilization Program. Under the act, industries may now obtain loans of up to $4 million or 60% of a total project cost, whichever is less. Previously, loans were limited to $2.5 million or 25% of a project's cost.

During the year, the ISGS completed several geotechnical investigations related to the Illinois bid to become the site for the Superconducting Super Collider, a high-energy physics facility proposed by the U.S. Department of Energy. In May, the ISGS hosted the 23d Forum on the Geology of Industrial Minerals in Aurora. Topics of discussion included (1) the future of industrial clays in Illinois, (2) the underground limestone and dolomite resources in central Illinois, (3) the markets for construction aggregates in the Chicago area, and (4) a historical perspective of Chicago's stone industry. Also, ISGS continued research on the effects of subsidence in Illinois coal mine areas under a long-term cooperative agreement with the U.S. Bureau of Mines.

The Northwestern University Steel Resource Center, funded by the American Iron and Steel Institute, studied ways in which computer programs can cut costs and improve quality in continuous casting, improvements in zinc-electroplated steel, and opportunities to use computer-based automation and information systems in steel manufacture.

The U.S. Bureau of Mines distributed over $707,000 in contracts and grants to Illinois firms, contractors, and research institutions in fiscal year 1987. Of this total, $100,000 was distributed to the University of Illinois for cooperative investigations of subsidence in Illinois. Southern Illinois University at Carbondale, the State's Mining and Mineral Resources and Research Institute, received $138,000 as its basic grant under Public Law 98-409 for training engineers and scientists in mineral-related disciplines.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—In terms of value, cement was the third-leading nonfuel mineral commodity produced in the State, following crushed stone and construction sand and gravel. Masonry cement sales increased by over 60% during 1987; portland cement sales remained essentially the same as in 1986. Four companies operated dry process plants in La Salle, Lee, and Massac Counties with seven of eight kilns in operation at some time during the year. Sales of masonry cement were reported by all companies except one. All companies produced gray portland Types I and II, general use and moderate heat, and three companies produced Type III, high-early-strength. Cement sales were to ready-mixed concrete companies (83%), highway contractors (9%), and concrete product manufacturers (6%). Lesser quantities were sold to other contractors, building material dealers, and miscellaneous customers. Most of the State's cement was shipped to consumers by truck in bulk form.

Approximately 2.9 million short tons of raw materials was consumed in the manu-

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facture of cement, including 2.5 million tons of limestone, 120,000 tons of clinker, 96,000 tons of clay and shale, 75,000 tons of gypsum, and lesser quantities of bauxite, fly ash, mill scale, sand, and slag.

Cement shipments to and within Illinois totaled 3.5 million tons of portland cement and 96,000 tons of masonry cement. Compared with 1986 figures, this was an increase of 221,000 tons of portland cement and 7,000 tons of masonry cement. Nearly 58% of the total shipments was to the Chicago metropolitan area.

In June, the Missouri Portland Cement Co. plant at Joppa reopened when one of its two kilns was put on-stream because of the improved outlook in cement demand. Previously, the facility had been used as a distribution center supplied by Davenport Cement Co.'s plant in Davenport, IA, and foreign imports.

Clays.—Six companies reported production of common clay and shale in Bond, Kankakee, La Salle, and Livingston Counties. Output dropped by about 50,000 short tons during 1987 because lesser quantities were used in cement manufacture. Value of production dropped about 10%. Most of the State's clay production was consumed in the manufacture of common and face brick followed by cement and drain tile. Fuller's earth was produced by two companies with operations in Pulaski County. The clay was used in the manufacture of absorbents for pet waste and oil and grease. Production and attendant value increased 15% and 31%, respectively.

USG Corp. of Chicago announced that it would spin off its A. P. Green Refractories Co. unit to shareholders in the first quarter of 1988 after a planned sale to another company failed early in the year because of financing obstacles. The A. P. Green unit operated a plant at Morris that produced refractory products for the cement and steel industries.

Fluorspar.—Illinois continued to lead the Nation in fluorspar production, accounting for over 90% of all U.S. shipments. Production and attendant value declined 9% and 6%, respectively, from 1986 levels. Ozark-Mahoning, the Nation's leading producer, operated two mines and a flotation plant in Hardin and Pope Counties and shipped acid-grade and metallurgical-grade fluorspar to the chemical and steel industries. Hastie Trucking & Mining Co. also shipped metallurgical grade fluorspar for making steel from its operation near Cave In Rock, Hardin County. Inverness Mining Co., a former producer, dried imported fluorspar at its facilities near Cave In Rock for sale primarily to the ceramics industry.

In August, a new 3-year agreement was reached between Ozark-Mahoning and members of the International Association of Machinists and Aerospace Workers Union. Also, Ozark-Mahoning began negotiating with Inverness Mining Co. to purchase its Minerva No. 1 Mine and related assets near Cave In Rock.

Lime.—Illinois ranked seventh of 34 States in lime production. Output and attendant value increased 7% and 3%, respectively, during the year. All production was at three Cook County plants. Marblehead Lime Co. operated plants at South Chicago and Thornton, and Vulcan Materials operated a plant at McCook. Production was primarily quicklime although a small amount of hydrated lime was also manufactured. Lime sales were mainly to the steel industry.

Illinois lime consumption, from all domestic sources, totaled 507,000 short tons of quicklime and 99,000 tons of hydrate. This was a slight increase over the 491,000 tons of quicklime consumed in 1986. However, hydrated lime consumption dropped 34,000 tons below the 1986 figure.

Peat.—Illinois ranked third of 22 States in peat sales. Quantity and value of sales increased 6% and 8%, respectively, in 1987. Five companies produced peat in Cook, Lake, and Whiteside Counties. Most of the peat was reed-sedge, with lesser amounts of humus, hypnum, and sphagnum. In descending order of use, sales were for general soil improvement, golf courses, vegetable growing, mushroom beds, and earthworm culture. Most of the sales were in packaged form.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1986 and estimates for 1985 and 1987. Data for odd-numbered years are based on annual company estimates.

Illinois ranked eighth of 50 States in production of sand and gravel for construction purposes. In terms of value, construction sand and gravel was the second-leading mineral commodity produced in the State, following crushed stone. Sales were estimated to have increased slightly in 1987, climbing to about 28.3 million short tons. Value of sales was estimated at $93.3 mil-

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lion, an increase of 13%.

Industrial.—Illinois ranked first of 39 States in industrial sand production. Sales increased nearly 8% to about 4.3 million short tons. Value of sales dropped by nearly 13%. Five companies produced silica sand from eight pits in La Salle, Mason, and Ogle Counties. La Salle County led the State's production. Most of the sand was shipped to consumers by rail, with lesser quantities by truck and barge. About 42% of the sand was sold for the manufacture of glass containers and flat glass. Sales for foundry molding and core were nearly 27% of total sales. Sand ground for fillers commanded the highest price per short ton.

Effective January 1, Ottawa Silica Co. of Ottawa, IL, and Pennsylvania Glass Sand Corp. of Berkeley Springs, WV, were merged and became U.S. Silica Co., the Nation's largest industrial sand producer. Both companies had been acquired in recent years by Pacific Coast Resources Co., a subsidiary of Rio Tinto Zinc Corp. PLC, a British firm.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Illinois ranked seventh of 49 States in crushed stone production. Output and attendant value increased 18% and 20%, respectively, during 1987. Crushed stone was produced by 106 companies at 199 quarries in 53 of the State's 102 counties. All production was limestone and dolomite except for 66,000 short tons of sandstone produced at a Hardin County quarry. Cook County led the State in production, followed by Will, St. Clair, La Salle, and Hardin Counties. Stephenson and Winnebago Counties had the greatest number of active quarries with 14 each. Nationally, Vulcan Materials' McCook Quarry and Material Service Corp.'s Thornton Quarry, both in Cook County, ranked fourth and eighth, respectively, in total output.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the four Illinois districts depicted in figure 1.

Table 3.—Illinois: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregates (+1-1/2 inch):		
Macadam	751	3,072
Riprap and jetty stone	677	3,836
Filter stone	104	418
Coarse aggregate, graded:		
Concrete aggregate, coarse	4,768	18,887
Bituminous aggregate, coarse	3,940	17,685
Bituminous surface-treatment aggregate	1,778	9,170
Railroad ballast	575	2,331
Fine aggregate (-3/8 inch):		
Stone sand, concrete	201	874
Stone sand, bituminous mix or seal	302	1,230
Screenings, undesignated	980	3,548
Coarse and fine aggregates:		
Graded road base or subbase	12,295	44,314
Unpaved road surfacing	3,150	11,474
Crusher run or fill or waste	468	1,653
Other construction[2]	332	1,181
Agricultural: Agricultural limestone	4,602	16,002
Chemical and metallurgical: Cement manufacture	1,762	4,999
Special:		
Mine dusting and acid water treatment	121	412
Other fillers or extenders	587	17,456
Other miscellaneous[3]	1,338	5,675
Other unspecified[4]	13,372	51,996
Total[5]	52,102	216,212

[1]Includes limestone, dolomite, and sandstone.
[2]Includes fine aggregate and terrazzo and exposed aggregate.
[3]Includes poultry grit and mineral food, other agricultural uses, lime manufacture, flux stone, asphalt fillers or extenders, and roofing granules.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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Table 4.—Illinois:[1] Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[2]	731	3,953	311	1,170	194	1,013	295	1,191
Coarse aggregate, graded[3]	6,164	25,679	819	5,144	1,940	9,288	2,138	7,962
Fine aggregate (-3/8 inch)[4]	1,149	4,279	34	W	138	W	162	679
Coarse and fine aggregates[5]	8,938	31,574	1,918	7,215	1,879	7,747	3,223	11,104
Other construction	24	69	47	299	18	619	178	622
Agricultural[6]	697	2,151	795	2,782	1,277	6,124	1,868	5,306
Chemical and metallurgical[7]	(8)	(8)	--	--	(8)	(8)	(8)	(8)
Special[9]	--	--	(8)	(8)	(8)	(8)	283	881
Other miscellaneous	1,025	3,282	569	17,878	1,494	4,673	402	1,463
Other unspecified[10]	10,072	37,561	1,067	4,813	1,257	5,534	975	4,088
Total[11]	28,801	108,549	5,560	39,300	8,198	34,997	9,524	33,297

W Withheld to avoid disclosing company proprietary data; included with "Other construction."

[1]Excludes 20,000 short tons valued at $70,000 not reported by county.

[2]Includes macadam, riprap and jetty stone, and filter stone.

[3]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.

[4]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screenings).

[5]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.

[6]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.

[7]Includes cement manufacture, lime manufacture, and flux stone.

[8]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[9]Includes mine dusting, asphalt filler, other fillers or extenders, and roofing granules.

[10]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[11]Data may not add to totals shown because of independent rounding.

One of Dravo Corp.'s operating units, Dravo Basic Materials Co. Inc., leased the former Missouri Portland Cement quarry near Cave In Rock and began operations in April. The quarry was closed in March 1986 when the Missouri Portland Cement plant at Joppa ceased production. Dravo began supplying stone to the cement plant when it was reopened in June.

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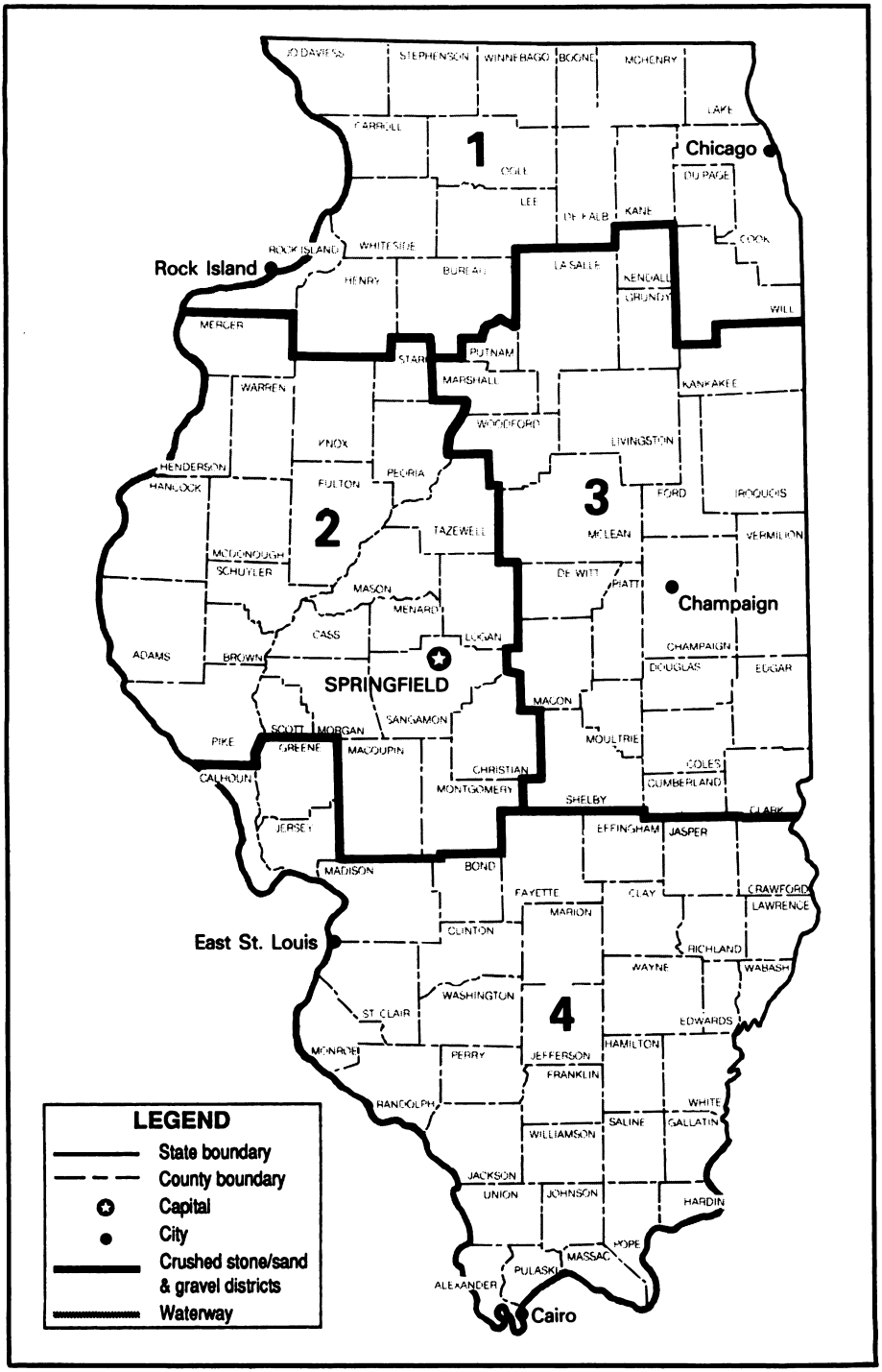

Figure 1.—Aggregate-producing districts in Illinois.

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Dimension.—One company produced dimension stone from a quarry in Kane County. Products included irregular shaped stone, and cut and dressed stone for veneer and flagging.

Tripoli.—Two companies operated mines and plants in Alexander County that produced crude and finished amorphous (microcrystalline) silica that was used as an abrasive and as fillers and extenders. Production of crude tripoli declined nearly 5% during the year. Value increased about 5%.

Other.—Gypsum mined in Michigan was calcined by National Gypsum Co. at its wallboard plant in Waukegan, Lake County. Production was down about 1,000 tons, attendant value declined 5%. Finished iron oxide pigments were manufactured in three counties. Production and value declined slightly. Crude perlite mined in other States was expanded by two companies at plants in Cook and Will Counties. Production declined about 1%; value increased nearly 9%. Three companies processed iron and steel slag from steel mills in Alton, Chicago, and Granite City. Total sales and value declined about 14% and 11%, respectively. About 58% of the slag was sold as road base material. Lesser quantities were sold for asphaltic concrete, mineral wool, railroad ballast, and fill. Sulfur was recovered at four refineries. Sales totaled nearly 256,000 metric tons, valued at $26 million. Vermiculite from other States was exfoliated by two companies with operations in Du Page and La Salle Counties. Sales and value were up about 8% and 3%, respectively.

METALS

Copper, Lead, Silver, and Zinc.—All metals from mines in Illinois are recovered as byproducts at Ozark-Mahoning's fluorspar operations in Hardin County. Lead, copper, and zinc recoveries were down about 30%, 19%, and 15%, respectively, in 1987. Silver recovery rose significantly. In terms of total value, zinc was the most valuable metal recovered, followed by lead, copper, and silver.

Iron and Steel.—The American Iron and Steel Institute reported Illinois as the fifth-leading State in raw steel production with output reaching 7.1 million short tons in 1987, an increase of 11% over 1986 output. The State ranked seventh of 10 States in pig iron production with output increasing nearly 8% over that of the previous year.

Acme Steel Co. posted its first profit in 1987 after being spun off from Interlake Inc. in 1986. In May, the firm acquired Universal Tool & Stamping Co. Inc. of Butler, IN, a major manufacturer and distributor of automotive and truck jacks, as a market for its steel.

Birmingham Steel Corp. began installing state-of-the-art rolling mill equipment at its plant in Kankakee. The new equipment was expected to be on line in the first quarter of 1988. Birmingham Steel is the largest U.S. manufacturer of steel roof support systems used in underground coal mining.

Granite City Div. of National Steel Corp. relined its B blast furnace early in the year. Steel slabs from National Steel's Great Lakes Div. at Ecorse, MI, and from European producers were shipped to Granite City. This enabled the rolling and finishing departments to continue full production while only the A blast furnace was in operation.

Both Keystone Steel & Wire Co. and Laclede Steel Co. completed improvement projects at their plants during 1987. Keystone upgraded the production facilities at its Peoria plant. Laclede Steel modernized the six-strand continuous casting machine at its Alton plant and installed a new breakdown mill.

In November, Northwestern Steel & Wire Co. became the object of a takeover bid by management and the company's union workers through an employee stock ownership plan. Negotiations on the takeover bid continued through yearend.

A nationwide strike against USX Corp. was resolved on January 31, ending a 6-month shutdown of its steelmaking operations. Employees at the South Works in Chicago were called back in early February, and the first steel was poured at the plant on February 16. By midyear, the plant was operating at its former level with nearly all workers back on the job.

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[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.

[2]Mining Engineering. Exploration 1987. V. 40, No. 5, May 1988, pp. 322-323.

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Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Dixon-Marquette Cement Inc., a subsidiary of Prairie Materials Sales Inc.	6428 Joliet Rd. Countryside, IL 60525	Quarry and plant	Lee.
Illinois Cement Co., a subsidiary of Centex Corp.	Box 442 La Salle, IL 61301	Quarry, clay pit, plant.	La Salle.
Lone Star Industries Inc., Cement and Construction Materials Group.	1 Greenwich Plaza Box 5050 Greenwich, CT 06836	____do ____	Do.
Missouri Portland Cement Co., a division of Cementia Holdings AG.	Box 4288 Davenport, IA 52801	Plant ____	Massac.
Do	____do ____	Quarry ____	Hardin.
Clays:			
Absorbent Clay Products Co ____	Box 120 Anna, IL 62906	Pit and plant ___	Pulaski.
Lowe's Southern Clay Inc ____	348 South Columbia South Bend, IN 46624	____do ____	Do.
Richards Brick Co ____	234 Springer Ave. Edwardsville, IL 62025	____do ____	Bond.
Streator Brick Systems Inc ____	West 9th St. Streator, IL 61364	____do ____	Livingston.
Fluorspar:			
Hastie Trucking & Mining Co ____	Cave In Rock, IL 62919 ____	Open pit ____	Hardin.
Ozark-Mahoning Co. a subsidiary of Pennwalt Corp.[1]	Box 57 Rosiclare, IL 62982	Underground mines and plant.	Hardin and Pope.
Gypsum (calcined):			
National Gypsum Co ____	2001 Rexford Rd. Charlotte, NC 28211	Plant ____	Lake.
Iron oxide pigments (finished):			
Pfizer Pigments Inc ____	235 East 42d St. New York, NY 10017	____do ____	St. Clair.
Prince Manufacturing Co ____	700 Lehigh St. Bowmanstown, PA 18030	____do ____	Adams.
Solomon Grind-Chem Service Inc __	Box 1766 Springfield, IL 62705	____do ____	Sangamon.
Iron and steel:			
Acme Steel Co ____	13500 South Perry Ave. Riverdale, IL 60627	____do ____	Cook.
Granite City Div. of National Steel Corp.	Box 365 Granite City, IL 62041	Iron and steel furnaces.	Madison.
LTV Steel Co ____	1641 GH Republic Bldg. Cleveland, OH 44101	____do ____	Cook.
Lime:			
Marblehead Lime Co., a subsidiary of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	Plants ____	Do.
Vulcan Materials Co ____	Box 7497 Birmingham, AL 35253	Plant ____	Do.
Peat:			
Henry Frenzer Inc ____	620 Webster St. Algonquin, IL 60102	Bog and plant ___	Do.
Joseph W. Grenus Excavating & Trucking.	39346 North Highway 83 Lake Villa, IL 60046	____do ____	Lake.
Hyponex Corp ____	2013 South Anthony Blvd. Fort Wayne, IN 46803	____do ____	Whiteside.
Markman Peat Co ____	Route 3 Morrison, IL 61270	____do ____	Do.
Roots Peat Farm ____	Box 6005 Lake Villa, IL 60046	____do ____	Lake.
Perlite (expanded):			
Manville Corp ____	Route 6, Box 3429 Joliet, IL 60434	Plant ____	Will.
Silbrico Corp ____	6300 South River Rd. Hodgkins, IL 60525	____do ____	Cook.
Sand and gravel:			
Construction (1986):			
R. A. Cullinan & Sons Inc ____	121 West Park St. Tremont, IL 61568	Pits and plants __	De Witt, McLean, Peoria, Tazewell, Woodford.
Elmhurst-Chicago Stone Co ___	Box 57 Elmhurst, IL 60126	____do ____	Cook, Du Page, Kane.
McHenry Sand & Gravel Co. Inc	Box 511 McHenry, IL 60050	____do ____	Boone and McHenry.
Material Service Corp., a division of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	____do ____	Grundy, Kane, McHenry.
Meyer Materials Co ____	Route 2, Box 56 Algonquin, IL 60102	____do ____	Kane and McHenry.
Thelen Sand & Gravel Inc ____	28955 West Route 173 Antioch, IL 60002	Pit and plant ___	Lake.
Vulcan Materials Co ____	Box 7497 Birmingham, AL 35253	Pits and plants __	Champaign, Livingston, McHenry, Macon.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Industrial:			
Manito Investment Co	Box 166 Tremont, IL 61568	Pit and plant	Mason.
Manley Bros. of Indiana Inc	Box 538 Chesterton, IN 46304	do	La Salle.
Unimin Corp	258 Elm St. New Canaan, CT 06840	Pits and plants	La Salle and Ogle.
U.S. Silica Co	Box 577 Ottawa, IL 61350	Pit and plant	La Salle.
Wedron Silica Co	Box 167 Wedron, IL 60557	do	Do.
Slag—iron and steel:			
Heckett Co	612 North Main St. Butler, PA 16001	Plant	Cook.
International Mill Service Co	1818 Market St. Philadelphia, PA 19103	Plants	Cook, Madison, Peoria.
St. Louis Slag Products Co. Inc., a division of Standard Slag Co.	Box 430 Granite City, IL 62040	Plant	Madison.
Stone (crushed limestone-dolomite):			
Columbia Quarry Co	Box 128 Columbia, IL 62236	Underground mine, quarries, plants.	Johnson, Monroe, Pulaski, St. Clair, Union.
Material Service Corp., a division of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	do	Cook, Logan, Menard, Montgomery, St. Clair, Vermilion, Will.
Rein, Schultz & Dahl Inc	5960 Falcon Rd. Rockford, IL 61109	Quarries and plants	Carroll, Douglas, Kane, Stephenson, Will.
Vulcan Materials Co	Box 7497 Birmingham, AL 35253	do	Clark, Cook, Iroquois, Kankakee, Livingston, Will.
Sulfur (recovered):			
Marathon Oil Co	Robinson, IL 62454	Plant	Crawford.
Mobil Oil Corp	Box 874 Joliet, IL 60434	do	Will.
Shell Oil Co	Box 262 Wood River, IL 62095	do	Madison.
UNOCAL Corp	1650 East Golf Rd. Schaumburg, IL 60196	do	Will.
Tripoli:			
Illinois Minerals Co., a subsidiary of Georgia Kaolin Co.	2035 Washington Ave. Cairo, IL 62914	Underground and open pit mines and plant.	Alexander.
Tammsco Inc	Box J Tamms, IL 62988	Underground mine and plant.	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	6051 West 65th St. Bedford Park, IL 60638	Plant	Du Page.
Strong-Lite Products Corp. of Illinois	Shipyard Rd. Seneca, IL 71611	do	La Salle.

[1]Also copper, lead, silver, and zinc.

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The Mineral Industry of Indiana

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Indiana Department of Natural Resources, for collecting information on all nonfuel minerals.

By James J. Hill[1]

Indiana's nonfuel mineral production was valued at $363.9 million in 1987, a 19% increase over the $305.3 million value reported in 1986. Ranking 25th nationally, the State led the Nation in production of masonry cement, dimension stone, and iron and steel slag. Indiana also was the Nation's largest producer of pig iron and raw steel, and it ranked third in the output of aluminum. In order of value, the leading industrial mineral commodities produced in the State were crushed stone, portland cement, construction sand and gravel, and masonry cement. Together they represented 84% of the State's total nonfuel mineral value. Sales increased for all mineral commodities produced in the State except for peat, which dropped about 44%, construction sand and gravel, and dimension stone, each of which declined about 4%.

Table 1.—Nonfuel mineral production in Indiana[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	W	W	395	$22,936	422	$32,299
Portland do.	W	W	2,136	92,327	2,320	103,177
Clays do.	740	$2,776	744	3,044	[2]1,037	[2]4,056
Gem stones	NA	[e]1	NA	1	NA	10
Peat thousand short tons	54	W	79	W	44	W
Sand and gravel:						
Construction do.	[e]18,600	[e]55,800	19,642	61,232	[e]18,900	[e]65,200
Industrial do.	182	1,209	193	1,490	230	1,357
Stone:						
Crushed do.	[3]23,384	[3]81,119	[e 3]22,600	[e 3]76,500	31,067	106,770
Dimension do.	169	20,186	[e]191	[e]20,252	184	23,115
Combined value of abrasives, clays (fire clay, 1987), gypsum, lime, stone (crushed marl, 1985-86), and values indicated by symbol W	XX	141,863	XX	27,566	XX	27,881
Total	XX	302,954	XX	305,348	XX	363,865

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Indiana in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel (construction).
Allen	Sand and gravel (construction), peat.
Bartholomew	Sand and gravel (construction).
Boone	Do.
Carroll	Do.
Cass	Cement, clays, sand and gravel (construction).
Clark	Cement, sand and gravel (construction), clays.
Clay	Clays.
Clinton	Sand and gravel (construction).
Dearborn	Do.
De Kalb	Do.
Delaware	Do.
Dubois	Clays.
Elkhart	Sand and gravel (construction).
Fayette	Do.
Floyd	Do.
Fountain	Sand and gravel (construction), sand (industrial), clays.
Franklin	Sand and gravel (construction).
Fulton	Do.
Gibson	Do.
Grant	Do.
Greene	Do.
Hamilton	Sand and gravel (construction), peat.
Hancock	Sand and gravel (construction).
Harrison	Sand and gravel (construction), sand (industrial).
Henry	Sand and gravel (construction).
Howard	Do.
Huntington	Sand and gravel (construction), clays.
Jackson	Do.
Jasper	Sand and gravel (construction).
Jay	Do.
Johnson	Do.
Knox	Do.
Kosciusko	Do.
Lake	Lime.
La Porte	Peat, sand (industrial), sand and gravel (construction).
Lawrence	Cement.
Madison	Sand and gravel (construction), peat.
Marion	Sand and gravel (construction).
Marshall	Do.
Martin	Gypsum.
Miami	Sand and gravel (construction).
Montgomery	Do.
Morgan	Clays, sand and gravel (construction).
Noble	Sand and gravel (construction).
Orange	Abrasives.
Owen	Sand and gravel (construction).
Parke	Do.
Pike	Do.
Porter	Sand (industrial).
Posey	Sand and gravel (construction).
Putnam	Cement, clays, sand and gravel (construction).
St. Joseph	Sand and gravel (construction).
Shelby	Do.
Starke	Do.
Steuben	Do.
Sullivan	Do.
Switzerland	Do.
Tippecanoe	Do.
Union	Do.
Vermillion	Sand and gravel (construction), clays.
Vigo	Sand and gravel (construction).
Wabash	Do.
Warren	Do.
Wayne	Do.
Whitley	Do.
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Employment.—Indiana's total civilian labor force was 2.75 million in 1987, about 9,000 persons less than in 1986. The State's unemployment rate fell from 6.7% in 1986 to 6.4% in 1987. Employment in mining and quarrying was about 8,600 persons, down from about 8,900 persons in 1986. Average weekly earnings increased from $610 in 1986 to $616 in 1987. Employment in the State's steel mills increased about 500 persons to 36,800 in 1987. Average weekly earnings were $648, compared with $630 in 1986.

Legislation and Government Programs.—The Indiana General Assembly passed a number of laws related to the mineral industry in 1987.

Public Law 165 established permitting

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procedures and fees for surface coal mining operations and provided for the deposit of fees into a reclamation fund for post-1977 abandoned mines.

Public Law 170 authorized the Department of Environmental Management to undertake removal or remedial action at the site of a hazardous substance release and to recover the cost of the action from the responsible party.

Public Law 243 amended or repealed obsolete provisions of the State's safety law for deep coal mines to make it consistent with the requirements of the Federal law.

Public Law 346 repealed Indiana's Mineral Extraction Mine Reclamation Act of 1986. The act, which regulated mining and reclamation of sand, gravel, and crushed limestone operations, was repealed because of its impact on local units of government and the unavailability of surety sources for bonding small operations. Regulation of these mining operations reverted back to county and local control.

The Indiana Geological Survey research centered on the State's clay and shale resources and their ceramic properties; oil yield and chemistry of the Pennsylvanian black shales; carbonate rocks and their use as construction aggregate, fillers, and whiting; and sand and gravel resources of several counties. Publications released during 1987 included an Annotated Bibliography of Indiana Geology, 1956-1975, and a report on the Upper Silurian and Lower Devonian Stratigraphy of the Central Illinois Basin as well as several coal maps.

In fiscal year 1987, the Division of Reclamation within the Department of Natural Resources received $8 million in Federal funds for its Abandoned Mine Land Program, Small Operators Assistance Program, and administrative functions. The division had 6 clay, 34 surface coal, and 3 underground coal mining permits under its jurisdiction at yearend.

The U.S. Bureau of Mines granted $183,000 in fiscal year 1987 to the Mining and Mineral Research Institute of Purdue University in West Lafayette under Public Law 98-409. Under the act, funds are channeled to research institutions to assist in the training of engineers and scientists in mineral-related disciplines.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Nationally, Indiana continued to rank 1st and 10th, respectively, in shipments of masonry cement and portland cement. Modest increases in sales and value were reported for both types of cement. In terms of value, cement (portland and masonry) was the leading nonfuel mineral commodity produced in the State, accounting for 37% of the State's total nonfuel mineral value. Three companies produced both portland and masonry cement at four plants in Cass, Clark, Lawrence, and Putnam Counties. One of the companies, Lehigh Portland Cement Co., also produced aluminous cement (calcium aluminate cement) at its Buffington Station plant at Gary, Lake County. This specialized cement, not included in Bureau of Mines statistics, is used for lining blast furnaces of steel mills. At the other plants, Types I and II—general-use and moderate-heat cement accounted for nearly 90% of the total portland cement sales. All companies produced Type III—high-early-strength portland cement. Sales by two companies included small quantities of white portland cement.

Cement sales were to ready-mixed concrete companies (73%), concrete product manufacturers (12%), highway contractors (10%), building material dealers (5%), and other contractors and miscellaneous customers (less than 1%). Approximately 95% of the finished portland cement was shipped to consumers by truck in bulk form. Cement shipments to and inside Indiana during 1987 included 1,704,000 short tons of portland cement and 103,000 tons of masonry cement. Compared with 1986 data, this represented 124,000 tons more of portland and 6,000 tons more of masonry cement.

The manufacture of cement in the State consumed 4.3 million short tons of raw materials. Of this, approximately 3.4 million tons was limestone, 588,000 tons was clay and shale, and 148,000 tons was gypsum. Lesser quantities of fly ash, pyrite, and sand were also consumed.

In 1987, Lehigh Portland began installing a 1,000-horsepower hydraulic roll crusher to serve the four finishing mills at its Mitchell plant. Finish grinding capacity was expected to increase 20%. Coplay Cement Co. received permission from the Cass County Board of Zoning Appeals to mine surficial material from a 240-acre tract near its Logansport plant for use in cement manufacture. Limestone underlying the tract was also to be tested for cement use.

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Clays.—Output of common clay and shale climbed to more than 1 million short tons, the highest level since 1979. Value increased by 33%, to more than $4 million. Indiana ranked 12th of 43 States in common clay and shale sales. Ten companies had operations in 10 of the State's 92 counties. Morgan County led the State's production, followed by Clay and Clark Counties. Fire clay was also produced by one company in Dubois County. Most of the State's output was used in the manufacture of cement, followed by brick and lightweight aggregate for concrete blocks. Other uses included filler for animal feed, drain tile, electrical porcelain, pottery, and rubber.

KPT Inc., a Taiwan-owned ceramic tile producer in Greene County that began production in 1986, had a very successful year. At yearend, the firm was planning a $3 million expansion of its highly automated plant in Bloomfield, bringing its total investment to $9 million. The firm's work force, which totaled 60 persons, was expected to increase by 50%.[3]

Gypsum.—Indiana ranked seventh and eighth, respectively, in the production of crude and calcined gypsum. Two companies, National Gypsum Co. and USG Corp., each operated underground mines and plants at Shoals in Martin County. USG also operated a wallboard plant at East Chicago in Lake County using crude gypsum from a mine it operated in Michigan. Quantity and value of crude gypsum produced increased 2% and 14%, respectively, compared with that of 1986. Average value per short ton increased 11%. Quantity of calcined gypsum produced increased nearly 3% and value about 2%. Average value per ton dropped slightly. Most of the gypsum mined in the State was used in the manufacture of wallboard. Lesser quantities were used in cement and plasters, and for soil conditioning.

Lime.—Indiana ranked ninth of 34 States in lime production. Two companies produced quicklime during 1987. Inland Steel Co. operated a plant at Indiana Harbor, and Marblehead Lime Co. operated a plant at Buffington Station near Gary. Both companies received limestone from Michigan and converted it to quicklime for the steel industry. Production rebounded by nearly 29% following a 10-year low reached in 1986, when a lengthy strike against USX Corp. took place. Total value of sales increased only 3%.

Peat.—Indiana ranked fourth nationally in sales of peat, dropping from third place in 1986. Sales were down about 44% with the largest decline in sales for peat used as an ingredient for potting soil. Five companies, with operations in Allen, Hamilton, La Porte, and Madison Counties, harvested peat for use in general soil improvement, golf courses, earthworm culture, ingredient for potting soil, nurseries, and as a seed inoculant. Most peat produced in the State was sold in packaged form; reed sedge was the predominant type harvested.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the third leading nonfuel mineral commodity produced in the State, following cement (masonry and portland) and crushed stone. Production was estimated to have declined about 4%. Average value per short ton increased by nearly 11%.

Early in the year, ARC America Corp. of Newport Beach, CA, a wholly owned subsidiary of Consolidated Gold Fields PLC of the United Kingdom, acquired American Aggregates Corp. of Greenville, OH, which had sand and gravel operations in Indiana, Michigan, and Ohio. American Aggregates was the second largest sand and gravel producer in Indiana in 1986, with four operations in Hamilton, Marion, and Wayne Counties.

Industrial.—Sand used for industrial purposes was produced by four companies from pits in Fountain, Harrison, La Porte, and Porter Counties. Production increased 19% compared with 1986 figures, to nearly 230,000 short tons, the highest level of production since 1981. Total value declined nearly 9%, with average value per short ton dropping from $7.73 in 1986 to $5.91 in 1987. The major use of the State's output was for refractory sand, followed by molding and core sand for foundries, and other miscellaneous uses. Sand used for molding and core declined 16% in 1987 because steel mills in the Chicago District have been switching to continuous casters that do not require ingot molds.[3]

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Indiana ranked 15th nationally in crushed stone production. Output and value increased 37% and 40%, respectively, compared with figures estimated for 1986. Production occurred at 89 quarries in 43 of

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the State's 92 counties. The largest number of quarries (six) were in Crawford and Putnam Counties, with Crawford County leading the State's production. Table 4 presents end-use data for crushed stone produced in the three Indiana districts depicted in figure 1.

Two crushed stone quarries in the Indianapolis area and another near Spencer in Owen County changed hands when American Aggregates was purchased by ARC America during the year. In 1985, American Aggregates was Indiana's seventh largest producer.

Table 3.—Indiana: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	219	871
Riprap and jetty stone	739	2,742
Filter stone	152	634
Other coarse aggregate	340	1,339
Coarse aggregate, graded:		
Concrete aggegate, coarse	3,566	10,273
Bituminous aggregate, coarse	2,202	6,692
Bituminous surface-treatment aggregate	778	2,671
Railroad ballast	945	3,475
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	127	502
Screenings, undesignated	188	685
Coarse and fine aggregates:		
Graded road base or subbase	2,078	7,191
Unpaved road surfacing	1,410	5,142
Crusher run or fill or waste	1,172	4,146
Other construction[2]	981	3,517
Agricultural: Limestone	1,932	7,358
Chemical and metallurgical: Cement manufacture	3,584	10,092
Special: Other miscellaneous[3]	420	1,774
Other unspecified[4]	10,239	37,668
Total	31,067	[5]106,770

[1]Includes limestone, dolomite, sandstone, and marl.
[2]Includes coarse aggregate, fine aggregate, stone sand (concrete), coarse and fine aggregates, and terrazzo and exposed aggregate.
[3]Includes flux stone, sulfur oxide removal, mine dusting and acid water treatment, asphalt fillers or extenders, whiting or whiting substitute, other fillers or extenders, poultry grit and mineral food, other agricultural uses, and waste material.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.

Table 4.—Indiana: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	291	1,345	349	1,426	551	1,788
Coarse aggregate, graded[2]	2,093	7,944	479	1,931	5,260	14,575
Fine aggregate (-3/8 inch)[3]	213	805	141	553	93	329
Coarse and fine aggregates[4]	1,401	5,281	1,546	5,457	1,811	6,185
Other construction	607	2,119	1	1	55	189
Agricultural[5]	890	3,490	386	2,090	788	2,533
Chemical and metallurgical[6]	W	W	W	W	2,331	8,195
Special[7]	W	W	W	W	W	W
Other miscellaneous	615	1,241	902	1,582	23	92
Other unspecified[8]	4,604	15,978	3,879	15,091	1,756	6,598
Total[9]	10,714	38,203	7,684	28,133	12,668	40,434

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, and coarse aggregate (graded).
[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screenings).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, crusher run or fill or waste, and coarse and fine aggregates.
[5]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[6]Includes cement manufacture, flux stone, and sulfur oxide removal.
[7]Includes mine dusting, asphalt filler, whiting or whiting substitute, other fillers or extenders, and waste material.
[8]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[9]Data may not add to totals shown because of independent rounding.

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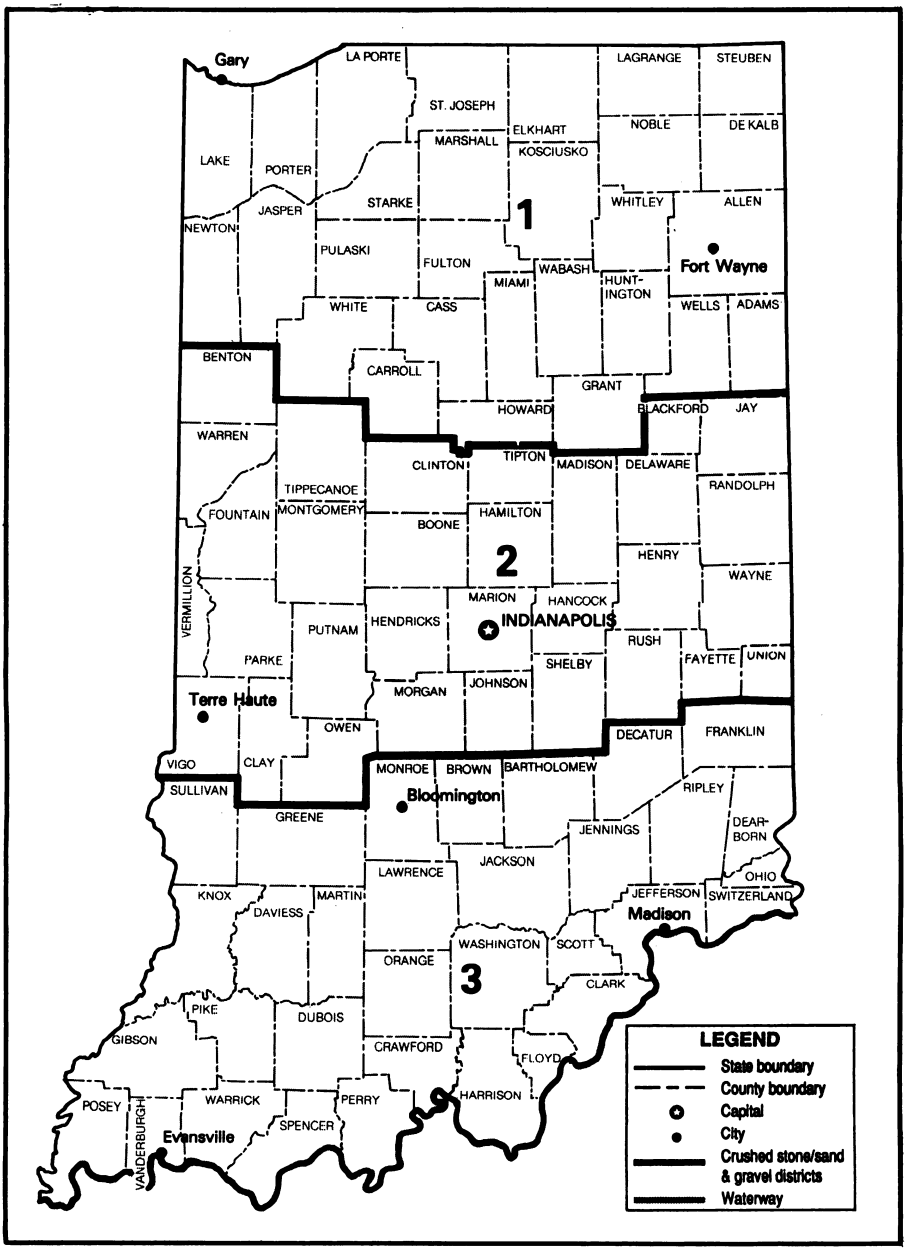

Figure 1.—Aggregate-producing districts in Indiana.

Dimension.—Indiana was the Nation's largest producer of dimension stone in 1987 after ranking second in 1986. Output declined about 4% during the year; value increased about 14%. Stone was produced by 13 companies from quarries in 6 counties.

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Table 5.—Indiana: Dimension stone sold or used by producers in 1987, by use

Use	Quantity (short tons)	Cubic feet (thousands)	Value (thousands)
Rough stone:			
Rough blocks for building and construction	123,839	1,708	$9,276
Other[1]	12,744	173	1,447
Dressed stone:			
Ashlars and partially squared pieces	22,418	309	6,065
Other[2]	24,608	339	6,327
Total	183,609	2,529	23,115

[1]Irregular shaped stone and uses not specified.
[2]Dressed slabs and blocks for building and construction, monumental, flagging, and uses not specified.

Other Industrial Minerals.—Hindostan Whetstone Co. continued to mine a small quantity of abrasive sandstone at its quarry at Orleans in Orange County for the manufacture of cuticle removers and sharpening stones. Both production and value increased during 1987. Manufactured abrasives (iron and steel shot and grit) were produced by US Abrasives Inc. at a plant in Tippecanoe, Marshall County. Perlite mined in other States continued to be expanded in Indiana by four companies for use as plaster aggregate, block insulation, filler, and filter aids. Modest increases were reported in production and value. Iron and steel slag from Indiana steel mills was processed by three companies with six plants in Lake and Porter Counties. Processed slag sales totaled 4.3 million short tons valued at $12.1 million. Over one-half of the processed slag sold was used as road base material. Elemental sulfur continued to be recovered by Amoco Oil Co. at its Whiting refinery in Lake County.

METALS

Aluminum.—Indiana ranked third of 14 States in primary aluminum production after ranking fourth in 1986. Aluminum Co. of America (Alcoa) was the State's sole producer, with operations near Evansville in Warrick County, southwestern Indiana. Production increased nearly 11% over that of 1986. In late July, Alcoa restarted its last idle potline, which had been idle since September 1984. The startup allowed the recall of 24 employees. During the year, Alcoa enlarged its rolling mills at the Warrick operations and completed construction of an advanced aluminum-coating line. Work began on a second coating line that was expected to be completed by mid-1988.

Iron and Steel.—Indiana continued to be the Nation's leading producer of raw steel. The American Iron and Steel Institute reported raw steel production in Indiana at 19.3 million short tons, a nearly 15% increase over the 16.8 million tons produced in 1986. Pig iron production increased at a slightly higher percentage rate, reaching its highest level since 1981. Many factors contributed to the rebound of the State's steel industry. Inefficient and unprofitable plants and facilities were closed. New contracts with the labor unions resulted in work rule changes and lower wages. Large investments of capital were made to modernize facilities. And, last but not least, the voluntary restraint agreement program authorized by Public Law 98-573 of 1984 limited the penetration of foreign steel into U.S. markets.

Several positive developments took place in the State's steel industry. Bethlehem Steel Corp. restarted the 110-inch plate mill at its Burns Harbor plant in August, citing increased demand for plate products. The mill had been idled in 1984 because foreign imports had penetrated its traditional markets.

Inland Steel Industries Inc. and Nippon Steel Corp. of Japan began construction of a $400 million, ultramodern cold-rolling mill near New Carlisle, St. Joseph County. Expected to be completed in 1989, the plant will have an annual capacity of 1 million short tons of cold-rolled steel and will be jointly owned by Inland Steel (60%) and Nippon (40%). About 230 persons will be employed at the facility. Inland Steel also announced that it would invest $55 million to install two "walking-beam" slab reheating furnaces at its 80-inch hot-strip mill at its Indiana Harbor Works, which are expected to increase yield by 50%. The first furnace will be on-line in August 1989 and

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the second in April 1990.

LTV Steel Co. completed a $114 million renovation of its No. 4 blast furnace at the Indiana Harbor Works in July. The startup allowed LTV to utilize the full capability of its slab caster without purchasing hot metal from other sources. Also, LTV's union workers ratified a new contract on August 6 that called for work rule changes and modifications of insurance and pension plans. The savings allowed LTV to reduce labor costs by about $3.00 per hour. LTV has been in bankruptcy proceedings since July 1986.

In September, Nucor Corp., a North Carolina-based steelmaker, began construction on a new minimill in west-central Indiana, near Crawfordsville, that was expected to employ about 600 persons by the end of 1989. The $225 million facility will employ new technology to make sheet steel, which has been almost the exclusive domain of the major integrated steelmakers.

USX resolved its 6-month labor dispute on January 31. Its Gary Works came back on-stream in early February and by mid-year was predicing at its prestrike level.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.
[2]The Indianapolis Star. Divided Greene County Teeters Economically But Doesn't Fall. Dec. 22, 1987.
[3]Rock Products. Steel Casters Reduce Industrial Sand Demand. V. 90, No. 3, Mar. 1987, p. 26.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives, natural:			
Hindostan Whetstone Co	Box 862 Bedford, IN 47421	Quarry Plant	Orange. Lawrence.
Aluminum:			
Aluminum Co. of America	Warrick Operations Box 10 Newburgh, IN 47630	Smelter and fabricating plant.	Warrick.
Cement:			
Coplay Cement Co., a subsidiary of Société des Ciments Française:	Box 35750 Louisville, KY 40232		
Logansport plant[1 2]		Plant, quarry, clay pit	Cass.
Speed plant[1 2]		do	Clark.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG:	Box 1882 Allentown, PA 18105		
Buffington Station plant		Plant	Lake.
Mitchell plant		Plant and quarry	Lawrence.
Lone Star Industries Inc., Greencastle plant.[1 2]	Box 5050 Greenwich, CT 06836	Plant, quarry, clay pit	Putnam.
Clays:			
General Shale Products Corp	Box 96 Mooresville, IN 46158	Pits and plant	Morgan.
Hydraulic-Press Brick Co., Haydite Div.	Brooklyn, IN 46111	Pit and plant	Do.
Log Cabin Coal Co.	304 South Depot St. Brazil, IN 47834	Pits and plant	Clay.
Gypsum:			
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	Underground mine and plant.	Martin.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do Plant	Do. Lake.
Iron and steel:			
Bethlehem Steel Corp	Bethlehem, PA 18016	Mill (integrated)	Porter.
Continental Steel Corp	Box 5049 Kokomo, IN 46902	Minimill	Howard.
Inland Steel Co., a subsidiary of Inland Steel Industries Inc.	3210 Watling St. East Chicago, IN 46312	Mill (integrated)	Lake.
LTV Steel Co	3001 Dickey Rd. East Chicago, IN 46312	do	Do.
National Steel Corp., Midwest Steel Div.	U.S. 12 Portage, IN 46368	Mill (rolling)	Porter.
USX Corp., Gary Works Div	1 North Broadway Gary, IN 46402	Mill (integrated)	Lake.
Lime:			
Inland Steel Co., a subsidiary of Inland Steel Industries Inc.	3210 Watling St. East Chicago, IN 46312	Plant	Do.
Marblehead Lime Co., a subsidiary of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	do	Do.
Peat:			
Beusching Peat Moss and Black Dirt.	9134 Cook Rd., Route 3 Fort Wayne, IN 46818	Bog and plant	Allen.
Felger's Peat Moss and Black Dirt.	9912 Valentine Rd. Fort Wayne, IN 46818	do	Do.
Filbrun Peat Moss	Route 2, Box 269 Pendleton, IN 46064	do	Madison.

See footnotes at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Peat —Continued			
Hyponex Corp	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bogs and plant	Hamilton.
Millburn Peat Co. Inc	Box 236 La Porte, IN 46350	do	La Porte.
Perlite (expanded):			
Chemrock Corp	Box 5465 Lafayette, IN 47903	Plant	Tippecanoe.
Grefco Inc	Box 48 Crawfordsville, IN 47933	do	Montgomery.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	do	Martin.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Do.
Sand and gravel:			
Construction (1986):			
ARC America Corp	Drawer 160 Greenville, OH 45331	Pits and plants	Hamilton, Marion, Wayne.
Hilltop Basic Resources Inc	630 Vine St. Cincinnati, OH 45202	Pit and plant	Switzerland.
Irving Materials Inc	Box 369, Rural Route 5 Greenfield, IN 46140	Pits and plants	Fayette, Hamilton, Henry, Madison, Wayne.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27622	do	Clark, Howard, Marion, Vermillion, Vigo.
OK Sand & Gravel Co. Inc	5320 South Belmont Indianapolis, IN 46217	Pit and plant	Marion.
Rogers Group Inc	Box 849 Bloomington, IN 47402	Pits and plants	Fountain, Greene, Knox, Morgan, Owen, Warren.
Vulcan Materials Co.[1]	Box 7497 Birmingham, AL 35253	do	La Porte, Parke, St. Joseph, Tippecanoe.
Industrial:			
Card Industrial Sand Corp	Box 1316 New Albany, IN 47150	Pit and plant	Harrison.
Crisman Sand Co. Inc	6480 Melton Rd. Portage, IN 46368	Pits and plants	Porter.
Harrison Steel Castings Co	Box 60 Attica, IN 47918	Pit and plant	Fountain.
Manley Bros. of Indiana Inc	Box 538 Chesterton, IN 46304	Pits and plants	La Porte.
Slag:			
Iron and steel:			
The Levy Co. Inc.[1]	Box 540 Portage, IN 46368	Plants	Lake and Porter.
Steel:			
Heckett Co	Box 1071 Butler, PA 16001	Plant	Lake.
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	Plants	Do.
Stone:			
Crushed:			
Limestone:			
ARC America Corp.	Drawer 160 Greenville, OH 45331	Quarries and plants	Greene, Hamilton, Marion, Owen.
The France Stone Co	Box 1928 Toledo, OH 43603	do	Allen and Putnam.
Irving Bros. Stone & Gravel Inc.	Box 300, Rural Route 13 Muncie, IN 47302	do	Blackford, Delaware, Grant, Huntington, Wells.
Martin Marietta Aggregates.	Box 30013 Raleigh, NC 27622	do	Clark, Howard, Madison, Putnam.

See footnotes at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Crushed —Continued			
Limestone —Continued			
Mulzer Crushed Stone Inc.	Box 248 Tell City, IN 47586	Quarries, mine, plants	Crawford.
Rogers Group Inc	Box 849 Bloomington, IN 47402	Quarries and plants	Lawrence, Monroe, Newton, Putnam.
Marl:			
Vernon M. Kaufman	Route 1 Topeka, IN 46571	Pit	Lagrange.
M. W. Wolkins	Box 332 Union, MI 49130	Pit	Elkhart.
Dimension:			
Limestone:			
Bybee Stone Co	Box 968 Bloomington, IN 47402	Quarry and plant	Monroe.
Elliot Stone Co. Inc	Box 743 Bedford, IN 47421	do	Lawrence.
Evans Quarries Inc	Box 711 Bedford, IN 47421	do	Do.
B. G. Hoadley Quarries Inc.	Box 1224 Bloomington, IN 47402	Quarries and plants	Lawrence and Monroe.
Independent Limestone Co.	6001 South Rockport Rd. Bloomington, IN 47401	Quarry and plant	Monroe.
Indiana Limestone Co. Inc.	Box 72 Bedford, IN 47421	Quarries and plants	Lawrence and Monroe.
Reed Quarries Inc	Box 64 Bloomington, IN 47402	Quarry and plant	Monroe.
Victor Oolitic Stone Co	Box 668 Bloomington, IN 47402	do	Do.
Sulfur (recovered):			
Amoco Oil Co	Box 710 Whiting, IN 46394	Elemental sulfur recovered as a byproduct of oil refining.	Lake.

[1]Also crushed stone.
[2]Also clays.

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The Mineral Industry of Iowa

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey Bureau, Division of Energy and Geological Resources, Iowa Department of Natural Resources, for collecting information on all nonfuel minerals.

By Leon E. Esparza[1] and Robert M. McKay[2]

Iowa's nonfuel mineral production in 1987 was valued at $305.1 million, an increase of about 23% over that reported in 1986. This was the second increase in 2 years. Nationally, Iowa ranked 29th in nonfuel mineral production. Most of the State's nonfuel mineral production was used in the construction industry. Favorable interest rates, general improvement of the farm economy, and increased funding for highway construction combined to increase construction outlays. These factors increased demand for raw materials supplied by the mineral industry. Value of nonresidential construction increased to $416.7 million, about 2% over that reported in 1986. Value of State road construction awards increased nearly 168% to $940 million. Mining employment totaled 2,200 persons, an increase of about 10%.

Table 1.—Nonfuel mineral production in Iowa[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	39	$3,372	48	$3,199	W	W
Portland do.	1,618	77,890	1,819	86,984	2,139	$104,457
Clays do.	503	2,450	486	1,421	473	1,495
Gem stones	NA	e1	NA	20	NA	W
Gypsum thousand short tons	1,639	13,682	1,826	12,602	1,874	12,887
Peat do.	11	415	14	381	24	W
Sand and gravel (construction) do.	e12,000	e30,500	14,511	40,418	e19,000	e63,800
Stone (crushed) do.	23,657	94,496	e23,400	e98,000	25,991	110,106
Combined values of other industrial minerals and values indicated by symbol W	XX	5,211	XX	5,707	XX	12,332
Total	XX	228,017	XX	248,732	XX	305,077

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Iowa in 1986, by county[1]

County	Minerals produced in order of value
Allamakee	Sand and gravel (construction).
Appanoose	Do.
Audubon	Do.
Benton	Do.
Black Hawk	Do.
Boone	Do.
Buena Vista	Do.
Butler	Do.
Calhoun	Do.
Cass	Do.
Cedar	Do.
Cerro Gordo	Cement, clays, sand and gravel (construction).
Cherokee	Sand and gravel (construction).
Chickasaw	Do.
Clay	Do.
Clayton	Do.
Clinton	Do.
Dallas	Sand and gravel (construction), clays.
Delaware	Sand and gravel (construction).
Des Moines	Gypsum, sand and gravel (construction).
Dickinson	Sand and gravel (construction).
Dubuque	Do.
Emmet	Do.
Fayette	Do.
Franklin	Do.
Greene	Do.
Grundy	Do.
Guthrie	Do.
Hancock	Do.
Hardin	Do.
Howard	Do.
Humboldt	Do.
Iowa	Do.
Jackson	Do.
Jasper	Do.
Johnson	Do.
Jones	Do.
Keokuk	Do.
Kossuth	Do.
Lee	Do.
Linn	Sand and gravel (construction), peat.
Louisa	Sand and gravel (construction).
Lyon	Do.
Marion	Sand and gravel (construction), gypsum.
Marshall	Sand and gravel (construction).
Mitchell	Do.
Monona	Do.
Montgomery	Do.
Muscatine	Sand and gravel (construction), peat.
O'Brien	Sand and gravel (construction).
Osceola	Do.
Page	Do.
Plymouth	Do.
Polk	Sand and gravel (construction), cement.
Pottawattamie	Sand and gravel (construction).
Sac	Do.
Scott	Cement, lime, clays, sand and gravel (construction).
Shelby	Sand and gravel (construction).
Sioux	Do.
Story	Do.
Tama	Do.
Van Buren	Do.
Wapello	Sand and gravel (construction), clays.
Washington	Sand and gravel (construction).
Webster	Gypsum, sand and gravel (construction).
Winnebago	Peat.
Winneshiek	Sand and gravel (construction).
Woodbury	Clays, sand and gravel (construction).
Worth	Sand and gravel (construction), peat.
Wright	Sand and gravel (construction).
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Legislation and Government Programs.—The Mining and Mineral Resources Research Institute at Iowa State University in Ames received a grant of $138,000 from the U.S. Bureau of Mines for fiscal year 1987 under authorization of Public Law 98-409. In addition to basic and applied research, the institute also performed work on a limited basis for industry, with emphasis on mineral characterization, mineral processing, and mining engineering.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—In 1987, the cement industry in Iowa continued gains in production and value that began in 1986. Production and value of portland cement were up about 18% and 20%, respectively. Masonry cement production increased slightly, while attendant value registered a marked increase. Principal markets for cement products were ready-mixed concrete companies (68%), concrete product manufacturers (18%), building material dealers and other uses (10%), and highway contractors (4%).

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1986 and estimates for 1985 and 1987. Data for odd-numbered years are based on annual company estimates.

Iowa's estimated 1987 construction sand and gravel production was about 19.0 million short tons, an increase of nearly 31% more than that of 1986. Value increased about 58% over that reported for 1986.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Limestone was the only rock type used in crushed stone production. Production and value in 1987 increased 11% and 12%, respectively. In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the six Iowa districts depicted in figure 1.

Table 3.—Iowa: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	261	1,060
Riprap and jetty stone	63	313
Filter stone	45	197
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,050	5,137
Bituminous aggregate, coarse	593	2,953
Bituminous surface-treatment aggregate	3,221	14,668
Fine aggregate (-3/8 inch): Screenings, undesignated	90	323
Coarse and fine aggregates:		
Graded road base or subbbase	3,144	10,716
Unpaved road surfacing	1,500	6,480
Crusher run or fill or waste	673	1,961
Other construction[2]	2,000	9,878
Agricultural: Agricultural limestone	2,145	8,884
Chemical and metallurgical: Cement manufacture	2,811	7,385
Special: Other miscellaneous[3]	1,403	12,004
Other unspecified[4]	6,991	28,148
Total[5]	25,991	110,106

[1]Limestone.
[2]Includes stone sand (concrete), stone sand (bituminous mix or seal), and railroad ballast.
[3]Includes poultry grit and mineral food, lime manufacture, flux stone, sulfur oxide removal, asphalt fillers or extenders, and glass manufacture.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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Table 4.—Iowa: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	W	W	165	580	W	W
Coarse aggregate, graded[2]	W	W	1,185	4,207	W	W
Fine aggregate (-3/8 inch)[3]	W	W	W	W	W	W
Combined coarse and fine aggregates[4]	W	W	1,159	3,687	W	W
Other construction	559	2,338	17	77	1,913	9,266
Agricultural[5]	(6)	(6)	(6)	(6)	559	7,169
Chemical and metallurgical[7]	--	--	(6)	(6)	(6)	(6)
Asphalt filler	--	--	--	--	--	--
Other unspecified[8]	357	1,965	3,882	14,847	1,138	6,247
Total[9]	916	4,303	6,408	23,398	3,610	22,683

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	88	384	34	172	8	40
Coarse aggregate, graded[2]	591	2,572	W	W	981	4,969
Fine aggregate (-3/8 inch)[3]	307	1,247	W	W	W	W
Combined coarse and fine aggregates[4]	2,021	5,952	623	3,276	665	2,744
Other construction	2	4	2,014	10,637	310	1,533
Agricultural[5]	535	1,934	463	2,714	283	1,055
Chemical and metallurgical[7]	1,902	4,787	(6)	(6)	--	--
Asphalt filler	(6)	(6)	--	--	--	--
Other unspecified[8]	2,472	8,704	304	1,398	1,454	5,599
Total[9]	7,917	25,584	3,438	18,197	3,701	15,941

W Withheld to avoid disclosing company proprietary data; included with "Other construction."

[1]Includes macadam, riprap and jetty stone, and filter stone.

[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.

[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screenings).

[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.

[5]Includes agricultural limestone and poultry grit and mineral food.

[6]Withheld to avoid disclosing individual company proprietary data; included with "Other unspecified."

[7]Includes cement manufacture, lime manufacture, flux stone, glass manufacture, and sulfur oxide removal.

[8]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[9]Data may not add to totals shown because of independent rounding.

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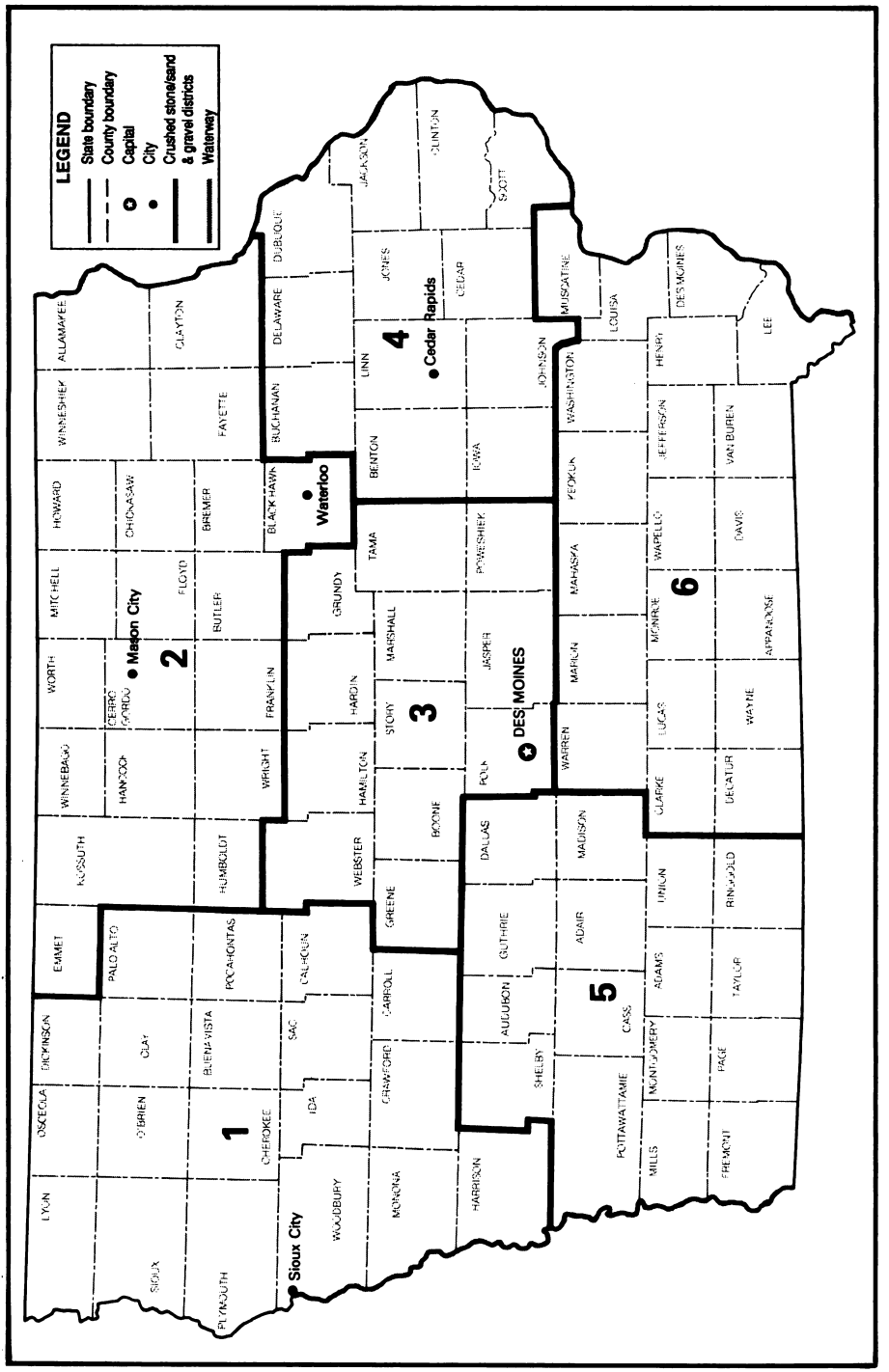

Figure 1.—Aggregate-producing districts in Iowa.

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Dimension.—Production and value of dimension stone in 1987 increased significantly compared with 1986 figures.

Other Industrial Minerals.—Clay production and value in 1987 decreased 3%; however, total value registered a 5% gain. Crude gypsum production increased slightly over that of 1986, and Iowa retained its national ranking of third. Lime production and value in 1987 were about the same as reported in 1986. Peat production and value increased significantly in 1987, owing in part to increased new construction and subsequent landscaping projects.

METALS

Metallic ores are not mined in Iowa; however, the State hosts processing facilities for aluminum, ferroalloys, iron and steel, molybdenum, and nickel. Metallic concentrates mined in other States and in foreign countries, and metallic scrap from various industries, are shipped to Iowa for processing. Late in the year, Foote Minerals Co. sold its ferroalloy plant at Keokuk to Keokuk Ferro-Sil Inc. The plant is the Nation's only producer of silvery pig iron.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.
[2]Geologist, Iowa Geological Survey Bureau, Iowa City, IA.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Davenport Cement Co., a subsidiary of Cementia Holdings AG.	220 Emerson Pl. Suite 300 Davenport, IA 52801	Quarry, clay pit, plant.	Scott.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG.	Box 1882 Allentown, PA 18105	____do _____	Cerro Gordo.
Monarch Cement Co _____	Humboldt, KS 66748 ___	Plant_____	Polk.
		Quarry and clay pit __	Madison.
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	Quarry and plant ___	Cerro Gordo.
Clays:			
Midland Brick Co _____	Box A Redfield, IA 50233	Pit and plant _____	Wapello.
Sioux City Brick & Tile Co___	501 Orpheum Bldg. Box 87 Sioux City, IA 51102	Pits and plants _____	Dallas and Woodbury.
Gypsum:			
Celotex Div., a subsidiary of Jim Walter Corp.	1500 North Dale Mabry Tampa, FL 33607	Open pit mine and plant.	Webster.
Georgia-Pacific Corp _____	133 Peachtree St., NE. Atlanta, GA 30303	____do _____	Do.
Kaser Corp_____	Box 3569 Des Moines, IA 50322	Underground mine and plant.	Marion.
National Gypsum Co _____	2001 Rexford Rd. Charlotte, NC 28211	Open pit mine and plant _____	Webster.
USG Corp_____	101 South Wacker Dr. Chicago, IL 60606	Underground mine and plant.	Des Moines.
		Open pit mine and plant.	Webster.
Lime:			
Linwood Mining and Minerals Corp.	Route 2 Davenport, IA 52804	Plant_____	Scott.
Peat:			
Eli Colby Co _____	Box 248 Lake Mills, IA 50450	Bog and plant_____	Winnebago.
Colby Pioneer Peat Co _____	Box 8 Hanlontown, IA 50444	____do _____	Worth.
Pikes Peat Co _____	Route 6, Box 21 Muscatine, IA 52761	____do _____	Muscatine.
Perlite (expanded):			
National Gypsum Co _____	2001 Rexford Rd. Charlotte, NC 28211	Plant_____	Webster.
USG Corp_____	101 South Wacker Dr. Chicago, IL 60606	____do _____	Do.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (construction, 1986):			
Acme Fuel & Material Co	Route 5, Box 34 Muscatine, IA 52761	Pit and plant	Muscatine.
G. A. Finley Inc	Box 406 Harlan, IA 51537	Pits and plants	Cass, Dallas, Montgomery, Page, Pottawattamie, Shelby.
Hallett Construction Co	Box 13 Boone, IA 50036	do	Audubon, Boone, Cherokee, Dallas, Franklin, Marshall, Osceola, Polk, Sac, Story.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	do	Various (20 counties).
Stevens Sand & Gravel Co. Inc	Route 4, Box 35 Iowa City, IA 52240	do	Johnson and Washington.
Van Dusseldorp Sand & Gravel Inc.	Box 156 Colfax, IA 50054	do	Jasper and Marion.
Stone (limestone):			
Crushed:			
B. L. Anderson Inc	123 Third Ave., SW. Cedar Rapids, IA 52406	Quarries and plants	Benton, Clinton, Jackson, Johnson, Jones, Linn, Tama.
Kaser Corp	7200 Hickman Rd. Des Moines, IA 50322	Underground mines, quarries, plants.	Des Moines, Jasper, Keokuk, Marion, Monroe, Polk, Poweshiek, Washington.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	do	Clarke, Decatur, Linn, Madison, Marshall, Polk, Story.
P. Niemann Construction Co.	106 North Maple St. Sumner, IA 50674	Quarries and plants	Black Hawk, Bremer, Buchanan, Butler, Chickasaw, Fayette, Winneshiek.
River Products Co	220 Savings & Loan Bldg. Iowa City, IA 52240	Underground mine, quarries, plants.	Johnson, Louisa, Washington.
Schildberg Construction Co. Inc.	Box 358 Greenfield, IA 50849	Quarries and plants	Adair, Adams, Cass, Madison, Pottawattamie, Union.
Dimension:			
Wm. Becker & Sons Stone Co.	1735 Kaufmann Ave. Dubuque, IA 52001	Quarry and plant	Dubuque.
Weber Stone Co.[1]	Route 1 Anamosa, IA 52205	do	Jones.

[1]Also crushed limestone.

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The Mineral Industry of Kansas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Kansas Geological Survey for collecting information on all nonfuel minerals.

By Jane P. Ohl[1] and David A. Grisafe[2]

Nonfuel mineral production in Kansas was valued at $319.6 million, relatively unchanged from 1985 and 1986. Nationally, the State ranked 28th in the value of nonfuel mineral production and accounted for 1.2% of the U.S. total. Portland cement, salt, and crushed stone accounted for almost 70% of the State's nonfuel mineral value. Total values of masonry and portland cements, clays, crude gypsum, and pumice decreased from those reported in 1986. Crude helium output nearly doubled over that of 1986. The State's remaining industrial mineral values were slightly to moderately higher than those reported in 1986. No metal production was reported.

Table 1.—Nonfuel mineral production in Kansas[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	W	W	51	$3,264	52	$3,150
Portland do.	W	W	1,763	91,110	1,697	81,045
Clays do.	878	$5,326	903	5,295	[2]604	[2]2,576
Gem stones	NA	[e]1	NA	3	NA	3
Salt[3] thousand short tons	1,790	71,970	1,656	68,887	1,689	70,148
Sand and gravel:						
Construction do.	[e]13,200	[e]31,800	15,609	33,721	[e]15,600	[e]37,800
Industrial do.	134	1,124	132	1,155	127	1,400
Stone:						
Crushed do.	15,653	57,155	[e]16,600	[e]60,300	19,319	69,628
Dimension do.	W	W	W	W	11	445
Combined value of clays (bentonite, 1987), gypsum, helium (crude and Grade-A), pumice, salt (brine), and values indicated by symbol W	XX	154,793	XX	53,910	XX	53,409
Total	XX	322,169	XX	317,645	XX	319,604

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Excludes salt in brines; value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Kansas in 1986, by county[1]

County	Minerals produced in order of value
Allen	Cement, clays.
Barber	Gypsum, sand and gravel.
Barton	Sand and gravel, clays.
Cherokee	Do.
Cheyenne	Sand and gravel.
Clark	Do.
Clay	Do.
Cloud	Clays, sand and gravel.
Comanche	Sand and gravel.
Cowley	Do.
Crawford	Clays.
Decatur	Sand and gravel.
Dickinson	Do.
Douglas	Do.
Edwards	Do.
Ellis	Do.
Ellsworth	Salt, clays, sand and gravel.
Finney	Sand and gravel.
Ford	Do.
Franklin	Clays.
Geary	Sand and gravel.
Grant	Do.
Gray	Do.
Greeley	Do.
Greenwood	Do.
Hamilton	Do.
Harper	Do.
Harvey	Do.
Haskell	Do.
Hodgeman	Do.
Jackson	Do.
Jewell	Clays.
Johnson	Sand and gravel.
Kearny	Do.
Kingman	Do.
Kiowa	Do.
Labette	Do.
Lincoln	Do.
Logan	Do.
Lyon	Do.
McPherson	Clays.
Marshall	Gypsum, sand and gravel.
Meade	Sand and gravel.
Montgomery	Cement, clays.
Morton	Sand and gravel.
Neosho	Cement, clays, sand and gravel.
Norton	Pumice, sand and gravel.
Phillips	Do.
Pottawatomie	Do.
Pratt	Do.
Reno	Salt, sand and gravel.
Republic	Sand and gravel.
Rice	Salt, sand and gravel.
Riley	Sand and gravel.
Rooks	Do.
Russell	Do.
Saline	Do.
Sedgwick	Sand and gravel, salt.
Seward	Sand and gravel.
Shawnee	Do.
Sheridan	Do.
Sherman	Do.
Stevens	Do.
Sumner	Do.
Thomas	Do.
Trego	Do.
Washington	Do.
Wichita	Do.
Wilson	Cement, clays.
Woodson	Clays.
Wyandotte	Cement, sand and gravel.
Undistributed[2]	Stone (crushed), helium, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Employment.—Employment in the mining industry, including persons employed by oil and gas extraction firms, was 12,100 persons, an increase of 7.6% from December 1986 to December 1987, according to the Kansas Department of Human Resources.

Environment.—As the Kansas salt industry celebrated its centennial, much attention was focused on pollution problems resulting from those 100 years of salt mining. Because salt from its plant polluted farm fields, the Cow Creek aquifer, and the Arkansas River in Rice County, American Salt Co. paid a multimillion-dollar judgment to farmers. The company, in an agreement with the Kansas Department of Health and Environment, will drill eight interceptor wells to clean up the aquifer. The wells are to discharge water from Cow Creek aquifer directly into Cow Creek or to repump polluted aquifer water into the already salty Arbuckle Formation at the 3,500-foot depth. The cleansing project will require about 35 years to bring aquifer salinity down to 250 parts per million, the maximum allowable for municipal drinking.

Pollution of Indian Creek in Linn County by pyritic materials from an abandoned mine stimulated the Kansas Mined Land Conservation and Reclamation Board to initiate a joint effort with Missouri to clean up areas along the State line.

Legislation and Government Programs.—Two laws related to mining and the environment were enacted by the State legislature in 1987. House bill 2108 gave discretionary powers to the Hazardous Waste Disposal Facility Approval Board to determine whether low-level radioactive waste should be stored underground or on the surface. Senate bill 134 exempts any person engaged in the extraction of clay for commercial purposes from having to reclaim the land in the same fashion as required for spent coal lands, when only small quantities of coal are removed during the extraction of the clay.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—The five plants operating in 1987 produced slightly more than 1.7 million short tons of portland cement and about 52,000 tons of masonry cement. The firms operated eight wet-process and seven dry-process kilns. A slight increase in the sale of masonry cement was the only bright spot in the portland and masonry cement industry. The masonry cement price declined approximately 5% to $60.58 per ton. Portland cement sales fell nearly 4%, total value fell 11%, and price per ton fell $3.92 to $47.76.

Raw materials consumed in cement manufacture were 2.2 million tons of limestone, 500,000 tons of cement rock, 200,000 tons of shale, and smaller amounts of clay, gypsum, iron ore, pyrite, mill scale, sand, sandstone, and various resins and chemicals. Fuels used to produce cement were predominantly natural gas, some soft and hard coals, and a very small amount of fuel oil.

In decreasing order of quantity, finished portland cement was sold to ready-mixed concrete companies (77%), highway contractors, concrete product manufacturers, building material dealers, and miscellaneous customers. Sales to highway contractors were up nearly 24% from those of 1986.

Bulk shipments of portland cement from plants to terminals were transported by truck (accounting for 63% of shipments) and by rail. Heartland Cement Co., which in 1986 had become a subsidiary of Rugby Portland Cement of the United Kingdom and Unicem of Italy, was resold to Instituto Finanziario Industriale S.p.A. of Italy in 1987. Heartland has a plant at Independence.

Table 3.—Kansas: Masonry cement salient statistics

(Short tons unless otherwise specified)

	1986	1987
Number of active plants	5	5
Production	49,617	45,713
Shipments from mills:		
Quantity	51,091	52,450
Value	$3,264,261	$3,149,722
Stocks at mills, Dec. 31	20,257	14,953

Table 4.—Kansas: Portland cement salient statistics

(Short tons unless otherwise specified)

	1986	1987
Number of active plants	5	5
Production	1,746,520	1,742,866
Shipments from mills:		
Quantity	1,762,802	1,696,772
Value	$91,110,212	$81,045,464
Stocks at mills, Dec. 31	225,892	202,620

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Clays.—In September, Hopworth Ceramic Holdings Ltd. of the United Kingdom, parent of W. S. Dickey Clay Manufacturing Co., sold Dickey's Pittsburg plant, one of its remaining clay sewer pipe plants in the United States, to the Mission Clay Products Corp. Mission Clay was a clay and construction products maker based in the Los Angeles, CA, area. The new owners planned to expand the payroll from 60 to about 100, possibly increasing output. The company's primary market area covered Iowa and Nebraska south through Texas and Louisiana.

Gypsum.—Crude and calcined gypsum were produced by Gold Bond Building Products Div. of National Gypsum Co. at Sun City and Medicine Lodge in Barber County, and by Georgia-Pacific Corp. at Blue Rapids in Marshall County. State output increased slightly over that of 1986, and the total value and unit price fell insignificantly.

Helium.—Kansas continued to be the Nation's leading producer of crude and Grade-A helium. Output and total value of crude helium rose 82% over that of 1986; crude production came from two plants in Ellsworth and Grant Counties. Grade-A helium was produced in Morton and Rush Counties as well as in Ellsworth and Grant Counties; output was down 15.6%.

Enron Helium Co., created in April 1986 by a merger between Northern Helex Co., a wholly owned subsidiary of InterNorth Inc., and Houston Natural Gas Co., closed its crude helium plant at Bushton in the summer. The closure and low summer production rates from other plants caused some private Grade-A helium producers to begin withdrawing crude helium stored in the U.S. Bureau of Mines Cliffside Field in Texas.

Salt.—Output and total value of salt and brines increased slightly from that of 1986, but price per short ton fell about 20%. Five firms produced sodium chloride (salt) in Kansas. A sixth firm, Vulcan Materials Co., Chemical Div., solution-mined brines from wells southwest of Wichita, and produced caustic soda, chlorine gas, and pentachlorophenol. None of Vulcan's brine solution was used as salt in food-related industries.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel output has increased about one-third and total value has risen about 43% since 1984. Carder Concrete Products Co. of Denver, CO, a subsidiary of Cement Roadstone Holdings PLC (CRH) of Dublin, Ireland, acquired Miller Material Co. of Kansas City.[3]

Industrial.—Three firms operated three industrial sand pits in Republic and Wyandotte Counties. Output continued to fall, but price per short ton rose about 25% over that of 1986. Industrial sand from the three company pits was used principally in fiberglass manufacture, sandblasting, traction, and filtration.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1986 and actual data for 1985 and 1987. Data for even-numbered years are based on annual company estimates.

Crushed stone output and value have been on a rising trend since a 1982-84 trough. In the last 4 years, output has increased 42% and total value increased more than 43%. The Kansas Aggregate Producers Association Inc. attributed the rise to economic conditions returning to normal and improved reporting by producers.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 6 presents end-use data for crushed stone produced in the six Kansas districts depicted in figure 1.

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Table 5.—Kansas: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Concrete aggregate (+1-1/2 inch):		
Macadam	64	215
Riprap and jetty stone	141	757
Filter stone	65	290
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,524	7,108
Bituminous aggregate, coarse	1,299	6,267
Bituminous surface-treatment aggregate	258	837
Railroad ballast	369	2,009
Fine aggregate (-3/8 inch):		
Stone sand, concrete	13	49
Stone sand, bituminous mix or seal	112	428
Screening, undesignated	1,148	4,077
Coarse and fine aggregates:		
Graded road base or subbase	3,162	10,626
Unpaved road surfacing	691	2,520
Crusher run or fill or waste	504	2,070
Other construction	243	839
Agricultural: Agricultural limestone	289	782
Chemical and metallurgical: Cement manufacture	3,045	8,215
Special: Other miscellaneous[2]	39	184
Other unspecified[3]	6,353	22,355
Total	19,319	69,628

[1]Includes limestone, sandstone and quartzite.
[2]Includes poultry grit and mineral food, chemical stone for alkali works, sulfur oxide removal, and roofing granules.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.

Table 6.—Kansas: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	113	453	52	445	W	W
Coarse aggregate, graded[2]	1,854	9,103	W	W	--	--
Fine aggregate (-3/8 inch)[3]	149	365	119	276	--	--
Coarse and fine aggregates[4]	1,752	7,865	460	2,070	W	W
Other construction	54	200	632	4,071	2	5
Agricultural[5]	49	154	31	95	--	--
Chemical and metallurgical[6]	653	1,669	(7)	(7)	--	--
Special[8]	--	--	(7)	(7)	--	--
Other miscellaneous	--	--	292	1,570	--	--
Other unspecified[9]	2,811	12,079	769	2,828	--	--
Total[10]	7,435	31,888	2,354	11,355	2	5

Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	1	14	W	W	W	W
Coarse aggregate, graded[2]	14	137	W	W	916	2,810
Fine aggregate (-3/8 inch)[3]	8	62	W	W	W	W
Coarse and fine aggregates[4]	--	--	562	1,343	1,582	3,935
Other construction	--	--	246	837	1,077	4,102
Agricultural[5]	--	--	39	108	173	438
Chemical and metallurgical[6]	--	--	--	--	2,137	5,147
Special[8]	--	--	--	--	--	--
Other miscellaneous	--	--	--	--	--	--
Other unspecified[9]	--	--	104	356	2,669	7,092
Total[10]	23	213	950	2,645	8,554	23,524

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Includes agricultural limestone and poultry grit and mineral food.
[6]Includes cement manufacture, chemical stone for alkali works, and sulfur oxide removal.
[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[8]Includes roofing granules.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

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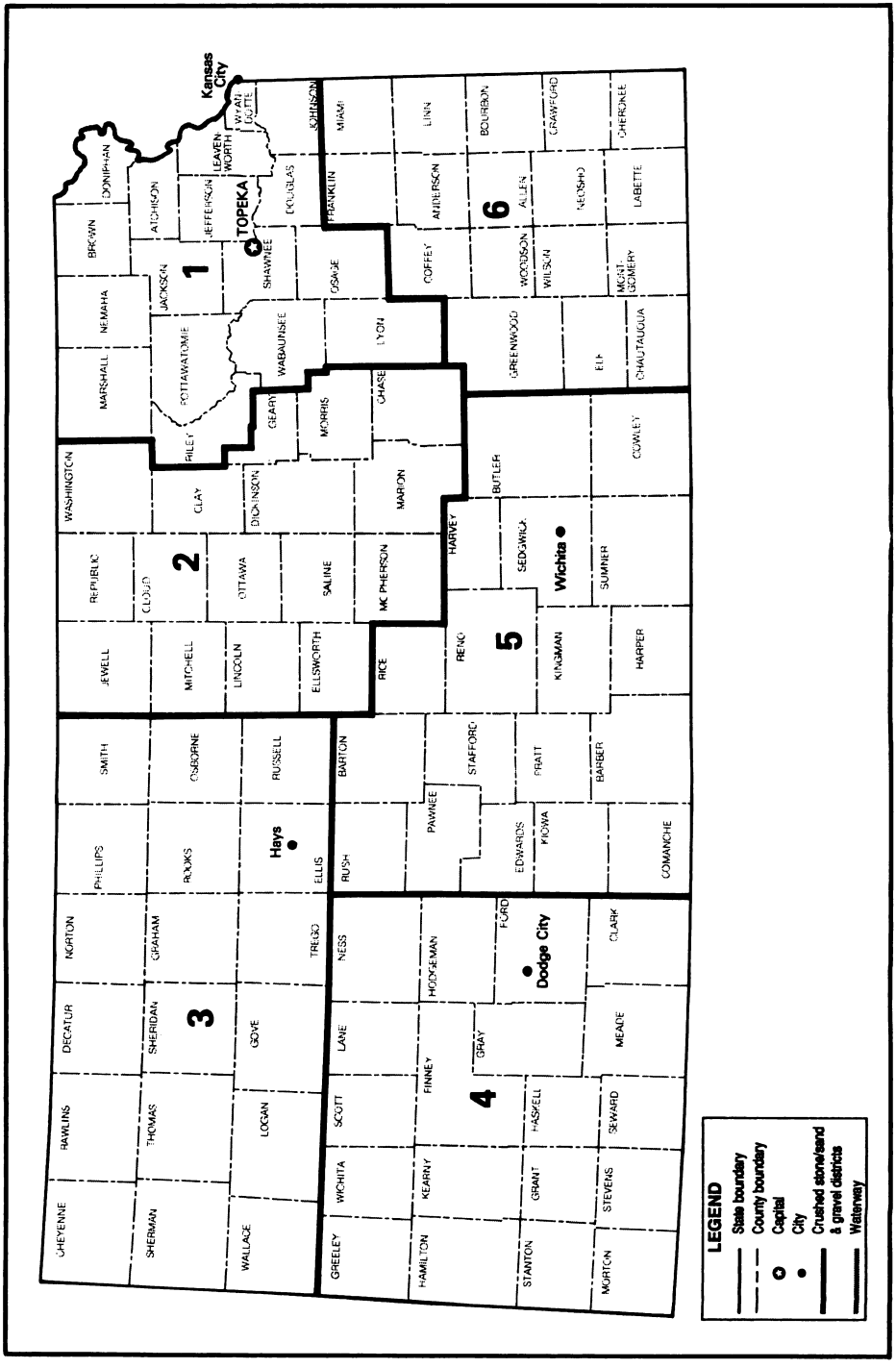

Figure 1.—Aggregate-producing districts in Kansas.

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Other Industrial Minerals.—Output and total value of expanded perlite fell slightly, breaking with the previous 3-year rising trend. Lite-Weight Products Inc. had the sole perlite expanding plant in Kansas. Calvert Corp., a subsidiary since 1985 of Miroil Co. of Allentown, PA, was the State's sole producer of pumice. the mine in Norton County increased slightly, but the total value and price per short ton of pumice declined. Petroleum-refining operations in Butler and Montgomery Counties continued to recover sulfur. Sales rose 47% over those of 1986, following a significant decrease in sales from 1985 to 1986. Average unit value decreased $9.45 per metric ton to $76.13.

[1]State Mineral Officer, Bureau of Mines, Denver, CO.
[2]Associate scientist, Mineral Information, Kansas Geological Survey, Lawrence, KS.
[3]Pit & Quarry. Oct. 1987, p. 16.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1 2]	Box 25900 Overland Park, KS 66225	Plant and quarry	Neosho.
LaFarge Corp.[3]	7701 East Kellogg St. Suite 240 Wichita, KS 67207	do	Wilson.
Heartland Cement Co., a subsidiary of Rugby Portland Cement and Unicem[4]	Box 42 Independence, KS 67301	do	Montgomery.
Lone Star Industries Inc.[5]	Box 12449 Dallas, TX 75225	do	Wyandotte.
The Monarch Cement Co.[6]	Box 187 Humboldt, KS 66748	do	Allen.
Clays:			
Buildex Inc., a division of Clemens Coal Co.	Box 15 Ottawa, KS 66067	Pit and plant	McPherson.
Cloud Ceramics, a division of General Finance Inc.	Box 369 Concordia, KS 66901	Pits and plant	Cloud.
Justin Industries Inc., Acme Brick Co	Box 98 Kanopolis, KS 67454	Pits and plants	Cherokee and Ellsworth.
Kansas Brick & Tile Co. Inc	Box 450 Hoisington, KS 67544	Pit and plant	Barton.
Micro-Lite Inc	Route 4, Box 50B Chanute, KS 66720	do	Woodson.
Gypsum:			
Georgia-Pacific Corp	133 Peachtree St., NE. Atlanta, GA 30303	Underground mine and plant.	Marshall.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	Open pit, underground mine, plant.	Barber.
Helium:			
Kansas Refined Helium Co	Otis, KS 67565	Plant	Rush.
Union Carbide Corp., Linde Div	Box 444 Somerset, NJ 08873	Plants	Ellsworth, Grant, Morton, Rush.
Perlite (expanded):			
Lite-Weight Products Inc	1706 Kansas Ave. Kansas City, KS 66105	Plant	Wyandotte.
Pumice and pumicite:			
Calvert Corp	Box 97 Norton, KS 67654	Pit and plant	Norton.
Salt:			
American Salt Co	3142 Broadway Kansas City, MO 64111	Wells and underground mine.	Rice.
Carey Salt Co., a division of Processed Minerals Inc.	1800 Carey Blvd. Hutchinson, KS 67501	Underground mine	Reno.
Cargill Inc., Salt Div	Box 1403 Hutchinson, KS 67501	Wells	Do.
Independent Salt Co	Box 36 Kanopolis, KS 67454	Underground mine	Ellsworth.
Morton Salt Co., a division of Morton Thiokol Inc.	110 North Wacker Dr. Chicago, IL 60606	Wells	Reno.
Vulcan Materials Co., Chemical Div	Box 7689 Birmingham, AL 35223	do	Sedgwick.

See footnotes at end of table.

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Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (construction):			
Associated Material & Supply Co. Inc	Box 4064 Wichita, KS 67204	Pit and plant	Sedgwick and Sumner.
Builders Sand Co	4150 Kansas Ave. Kansas City, KS 66106	Dredges and plants	Johnson, Shawnee, Wyandotte.
Holliday Sand & Gravel Co., a division of List & Clark Construction Co.[7]	6811 West 63d St. Overland Park, KS 66202	Pits and plants	Johnson and Wyandotte.
Ritchie Sand Co., a division of Ritchie Corp.	6500 West 21st St. Wichita, KS 67204	Dredge and plant	Sedgwick.
Stone:			
Crushed:			
N. R. Hamm Quarry Inc	Box 17 Perry, KS 66073	Quarries and plants	Various (9 counties).
Inland Quarries, a subsidiary of Americold Inc.	Box 2249 Kansas City, KS 66110	Underground mine and plant.	Wyandotte.
McAdam Construction Co. Inc	Main Street Moran, KS 66755	Quarries and plants	Allen, Anderson Bourbon, Linn.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	____do	Various (7 counties).
Midwest Minerals Inc	Box 412 Pittsburg, KS 66762	____do	Cherokee, Crawford, Labette, Montgomery, Neosho, Wilson.
Dimension:			
Bayer Stone Inc	6th and Mission St. Marys, KS 66536	Quarries	Pottawatomie and Riley.
H. J. Born Stone Co. Inc	Route 3, Box 312 Silverdale, KS 67005	____do	Chase and Cowley.
Sulfur (recovered):			
Farmland Industries Inc	North Linden St. Coffeyville, KS 67337	Secondary recovery plant.	Montgomery.
Texaco Refining & Marketing Co	Box 1650 Tulsa, OK 74102	____do	Butler.

[1]Also clays in Neosho County.
[2]Also crushed stone in Johnson, Linn, and Neosho Counties.
[3]Also clays and crushed stone in Wilson County.
[4]Also clays and crushed stone in Montgomery County.
[5]Also crushed stone in Wyandotte County.
[6]Also clays and crushed stone in Allen County.
[7]Also industrial sand in Wyandotte County.

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The Mineral Industry of Kentucky

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Kentucky Geological Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Garland R. Dever, Jr.[2]

The value of nonfuel mineral production in Kentucky in 1987 was about $290 million; the State ranked 30th nationally in value. Production of crushed stone, the State's leading nonfuel mineral commodity, increased by about 5 million short tons. That gain reflected strong demand from the construction industry and primarily accounted for the increase in total State value. The other mineral commodities produced in Kentucky showed less significant changes in output and value compared with 1986.

Kentucky remained the leading coal-producing State in the Nation. The coal industry was a significant component of the State's economy and provided a market for some nonfuel minerals. Developments in environmental and energy-related technologies continued to improve the market for the State's crushed limestone industry.

Table 1.—Nonfuel mineral production in Kentucky[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	775	$6,487	[2]721	[2]$3,450	1,031	$8,821
Gem stones	NA	[e]1	NA	3	NA	3
Sand and gravel (construction) thousand short tons	[e]7,600	[e]19,000	7,194	16,986	[e]7,100	[e]15,200
Stone (crushed) ---------- do	[3]38,022	[3]134,978	[e] [3]38,400	[e] [3]137,000	43,330	173,222
Zinc ---------- metric tons	W	W	W	W	10	9
Combined value of cement, clays (ball clay and fire clay, 1986), lime, sand and gravel (industrial), stone (crushed sandstone, 1985-86), and values indicated by symbol W ----------	XX	107,092	XX	109,826	XX	93,080
Total ----------	XX	267,558	XX	267,265	XX	290,335

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Kentucky in 1986, by county[1]

County	Minerals produced in order of value
Boone	Sand and gravel.
Boyd	Clays.
Breckinridge	Sand and gravel.
Bullitt	Clays.
Calloway	Sand and gravel.
Carlisle	Clays.
Carroll	Sand and gravel.
Carter	Clays.
Clinton	Sand and gravel.
Daviess	Do.
Graves	Clays, sand and gravel.
Hancock	Clays.
Hart	Sand and gravel.
Henderson	Do.
Jefferson	Cement, sand and gravel, clays.
Lewis	Sand and gravel.
Livingston	Do.
Martin	Do.
Meade	Do.
Oldham	Do.
Powell	Clays.
Trimble	Sand and gravel.
Union	Do.
Whitley	Clays.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—The Kentucky Supreme Court ruled in 1987 that the "broad-form deed" law passed by the Kentucky General Assembly in 1984 was unconstitutional and that surface mining is permissible under broad-form deeds. The 1984 law had limited mining under broad-form deeds to the method commonly known to be in use in the affected area at the time the deeds were signed, generally underground mining. It had essentially barred surface mining by the mineral owner without the surface owner's permission. The Supreme Court also reversed the 1956 State court decision in *Buchanan* v. *Watson*, which ruled that coal companies operating under broad-form deeds did not have to compensate surface owners for damages. However, an exemption from paying damages applies to deeds signed between May 6, 1956, and July 2, 1987.[3]

The State Supreme Court also was expected to rule in 1988 on the validity of the nominal tax rate levied on unmined coal reserves. The rate of one-tenth of one cent per $100 of assessed valuation was ruled unconstitutional in circuit court. If the Supreme Court upholds that decision, the coal industry tax rate could increase to twenty-one and four-tenths cents, the rate assessed on other property in the State.

The Kentucky Geological Survey and U.S. Geological Survey were considering a 3-year pilot program to determine coal resources available for economic development in eastern Kentucky. Resource estimates in the past were made without consideration for land use and technological factors that restrict or prohibit mining.

The University of Kentucky was awarded a contract by Cyprus Minerals Co. for research into long-term land development on the company's 17,000-acre Star Fire tract in eastern Kentucky where coal is recovered by mountain-top-removal methods. The purpose of Cyprus' Star Fire project was to develop plans for alternate land uses beyond the basic revegetation requirements of the Federal Surface Mining Control and Reclamation Act (Public Law 95-87). Preliminary research activities included an assessment of the need for development in the region, water resources inventory, soils and vegetation study, and investigation of the potential for cattle grazing and for industrial development on the reclaimed land.[4]

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Industrial minerals accounted for nearly all of Kentucky's $290 million in value of nonfuel mineral production. Crushed limestone accounted for 60% of the total value; lime and cement along with small quantities of ball and fire clays, 34%; and sand and gravel and common clay, 6%. Fluorspar, which was last mined in Kentucky in 1978, was expected to be produced again in the State in 1988.

Fluorspar.—In December, Kentucky-Illinois Fluorspar Corp. reopened a flotation plant near Salem in Crittenden County. Fluorspar production had last been reported in the State in 1978 when Frontier Spar Corp. closed its Babb-Barnes underground mine. Earlier in the year, Kentucky-Illinois Fluorspar had purchased from USX Corp. all the fluorspar reserves, mines, and processing facilities formerly owned by Marathon Oil Co., Cerro Corp., and United States Steel Corp. Cerro had owned Frontier Spar Corp. Removal of the State severance tax on fluorspar and other selected mineral commodities by the Kentucky Legislature in 1984 contributed to the reopening of the operation.[5] Fluorspar was produced in only two States in 1987 and was used primarily as a flux by the steel industry; it also was used to produce hydrofluoric acid.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Traditionally, crushed limestone produced in Kentucky has been marketed for use by the agricultural, coal, construction, and steel industries. Demand from the construction industry typically depended on economic conditions. Beginning in 1983, lower interest and inflation rates resulted in favorable conditions for home and highway construction and crushed stone production in Kentucky has increased by 14 million short tons in the last 5 years. Output of 43 million tons in 1987 was the highest ever reported in State history. Demand for crushed stone remained strong in central Kentucky as construction of an automobile-manufacturing plant improved economic conditions in that area. Also in 1987, legislation was enacted to raise revenue for a State highway construction program through a decal tax on trucks weighing in excess of 60,000 pounds. Markets for limestone used in agriculture and steelmaking are stable and mature in Kentucky.

The market for Kentucky's limestone resources continued to expand for use in environmental and energy-related applications. During the year, five limestone producers had contracts to supply limestone used to abate sulfur dioxide emissions at coal-fired utility plants. The Tennessee Valley Authority (TVA) near Paducah was constructing a 160-megawatt demonstration plant to test a fluidized-bed combustion technology system that was expected to utilize 2.80 tons of limestone per 1.0 ton of coal burned. The ratio of limestone per ton of coal burned depended on the sulfur content of the coal. Previously, the TVA had successfully used fluidized-bed combustion technology in a 20-megawatt pilot plant.

Limestone products were also used by the coal industry as rock dust for health and safety purposes in underground mines, to treat acid mine drainage, and in surface mine reclamation. The Kentucky Energy Cabinet (KEC) was involved in the TVA projects and in other technological research such as atmospheric fluidized-bed combustion designed to reduce sulfur dioxide emissions from coal-burning utilities. The KEC also analyzed limestone samples for possible commercial use as rock dust.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the four Kentucky districts depicted in figure 1.

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Table 3.—Kentucky: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	1,746	6,729
Filter stone	434	1,781
Coarse aggregate, graded:		
Concrete aggregate, coarse	3,352	12,402
Bituminous aggregate, coarse	3,633	14,464
Bituminous surface-treatment aggregate	1,083	3,860
Railroad ballast	97	421
Fine aggregate (-3/8 inch):		
Stone sand, concrete	319	975
Stone sand, bituminous mix or seal	1,056	4,082
Screening, undesignated	852	2,463
Coarse and fine aggregates:		
Graded road base or subbase	7,334	28,002
Unpaved road surfacing	1,121	4,093
Crusher run or fill or waste	1,496	5,476
Other construction[2]	195	706
Agricultural, agricultural limestone	1,656	5,993
Special: Other miscellaneous[3]	3,974	24,510
Other unspecified[4]	14,981	57,265
Total	[5]43,330	173,222

[1]Includes limestone, dolomite, and sandstone.
[2]Includes macadam.
[3]Includes poultry grit and mineral food, cement manufacture, lime manufacture, flux stone, chemical stone for alkali works, sulfur oxide removal, and mine dusting and acid water treatment.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.

Table 4.—Kentucky: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	1,015	3,366	204	853	793	3,733	222	789
Coarse aggregate, graded[2]	1,345	4,552	1,336	5,437	4,288	17,100	1,197	4,057
Fine aggregate (-3/8 inch)[3]	382	1,246	386	1,508	896	2,623	563	2,143
Coarse and fine aggregates[4]	1,908	6,307	1,830	7,345	4,457	17,693	1,757	6,227
Other construction	46	96	--	--	85	363	11	16
Agricultural[5]	289	955	469	1,972	457	1,903	470	1,437
Chemical and metallurgical[6]	--	--	W	W	(7)	(7)	--	--
Special[8]	--	--	--	--	(7)	(7)	--	--
Other miscellaneous	52	96	--	--	3,181	22,008	--	--
Other unspecified[9]	4,771	17,181	2,273	8,782	5,885	22,585	2,763	10,851
Total[10]	9,807	33,798	6,499	25,897	20,041	88,007	6,983	25,520

W Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete), stone sand (bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Includes agricultural limestone.
[6]Includes cement manufacture, lime manufacture, flux stone, and sulfur oxide removal.
[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[8]Includes mine dusting.
[9]Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.
[10]Data may not add to totals shown because of independent rounding.

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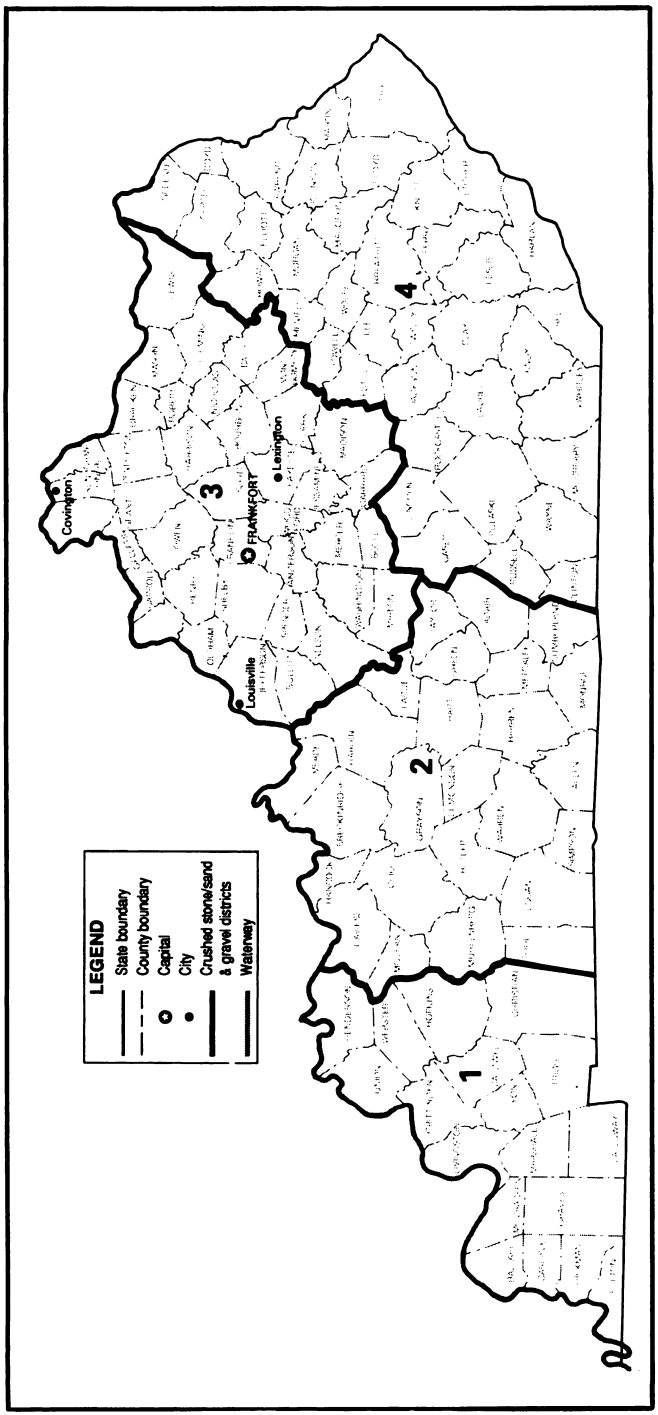

Figure 1.—Aggregate-producing districts in Kentucky.

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Other Industrial Minerals.—In 1987, ball (4), common (12), and fire (1) clays were produced at 17 mines and pits. Corbin Brick Co. Inc., Whitley County, was purchased by General Shale Products Corp., a subsidiary of Marley PLC of the United Kingdom. In Marion, Crittenden County, a new company, CeraTech Inc., opened a plant to manufacture industrial and high-temperature advanced ceramics using ball clay. The firm expected to produce about 2,000 short tons of ceramics. Lime was produced by one company with two operations in Mason and Pendleton Counties. Most of the lime produced at the Mason County plant was used in sulfur dioxide control applications. Output of construction sand and gravel remained at the 7-million-ton level for the fourth consecutive year. Nugent Sand Co. purchased Martin Marietta Corp.'s Milton pit in Carroll County for an estimated $5 million. The sale also included a fleet of barges and plant equipment. Nugent also operated dredges based in Trimble County on the Ohio River.

METALS

A small quantity of zinc was recovered as a byproduct at an underground limestone mine in Jessamine County. The value of that production is included in the State total as given in table 1. Aluminum and steel were the major metals manufactured in the State. Production and value of these commodities was proprietary.

Aluminum.—In December, Alcan Aluminum Corp. decided to restart the third of its three potlines, returning its Sebree smelter to full capacity of 163,000 metric tons per year. Alcan and the State's other primary aluminum producer, National Southwire Aluminum Co., were forced to pay an additional $7.1 million in October for electricity charges to the Big Rivers Electric Corp. The Franklin Circuit Court denied the two companies' request to place the funds in an escrow account pending an appeal to the Kentucky Public Service Commission on the rate structure that ties electricity rates to the market price for aluminum.

Iron and Steel.—Union workers at Armco Inc., the largest employer of the Ashland area with about 3,000 workers and the fifth-largest employer in the State, approved a concession package essentially lending the company $22.5 million for the purchase of a continuous-slab caster. Total cost of the caster was estimated at $82.4 million with construction expected to be completed by mid-1990. Armco decided on the modernization and expansion program because of the opening and continuing construction of three new Japanese automobile-manufacturing plants in Georgetown, KY; Smyrna, TN; and Marysville, OH.

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[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]Geologist, Coal and Minerals Section, Kentucky Geological Survey, Lexington, KY.
[3]The Courier-Journal. Broad-Form Deed Ruling Favors Some Landowners. July 3, 1987, p. 1.
Lexington Herald Leader. Strip-Mining Restrictions Struck Down. July 3, 1987, p. 1.
[4]Mining Engineering. May 1988, v. 40, No. 5, p. 323.
[5]Work cited in footnote 4.

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Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum (primary):			
Alcan Aluminum Corp	Sebree, KY 42555	Smelter	Webster.
National-Southwire Aluminum Co.	Box M Hawesville, KY 42348	do	Hancock.
Cement:			
Kosmos Cement Co. Inc.[1] [2]	Dixie Highway Box 72319 Louisville, KY 40272	Plant	Jefferson.
Clays:			
Ball clay:			
Kentucky-Tennessee Clay Co	Box 449 Mayfield, KY 42066	Mines and plant	Carlisle and Graves.
Old Hickory Clay Co	Box 66 Hickory, KY 42051	do	Graves.
Common clay:			
General Shale Products Corp	Box 3547 CRS Johnson City, TN 37602	Mine and plant	Jefferson and Whitley.
Kentucky Solite Corp	Box 27211 Richmond, VA 23261	do	Bullitt.
U.S. Brick Inc., Sipple Div	Box 567 Stanton, KY 40380	do	Powell.
Fire clay:			
Ford Burchett Clay Co	Route 1, Box 850 Olive Hill, KY 41164	Mine	Carter.
Ferroalloys:			
SKW Alloys Inc	Box 217 Calvert City, KY 42029	Plant	Marshall.
Graphite (synthetic):			
Ashland Petroleum Co., Carbon Fibers Div.[3]	Ashland, KY 41101	do	Boyd.
Sigri Carbon Corp	Box 229 Hickman, KY 42050	do	Fulton.
Superior Graphite Co	Box 535 Hopkinsville, KY 42240	do	Christian.
Iron and steel (pig iron):			
Armco Inc	Middletown, OH 45202	do	Boyd.
Newport Steel Corpp	9th & Lowell Sts. Newport, KY 41072	Plants	Campbell.
Lime:			
Dravo Lime Co., a subsidiary of Dravo Corp.[2]	One Gateway Center Pittsburgh, PA 15222	Mines and plants	Mason and Pendleton.
Perlite (expanded):			
International Permalite Co	300 North Haven Ave. Ontario, CA 91762	Plant	Boone.
Sand and gravel:			
Construction:			
Evansville Materials Inc	Box 249 Tell City, IN 47586	Dredges	Daviess.
Martin Marietta Corp.[2]	Box 30013 Raleigh, NC 27622	Pits	Carroll, Jefferson, Oldham.
Northern Kentucky Aggregates	11641 Mosteller Rd. Cincinnati, OH 45241	do	Boone.
Nugent Sand Co. Inc	Box 6072 1833 River Rd. Louisville, KY 40206	Dredges	Trimble.
Industrial:			
Industrial Supply House of Greenup Inc.	Box 647 422 Harrison St. Greenup, KY 41144	Pit	Lewis.
Stone (crushed):			
The Kentucky Stone Co	Box 7529 Louisville, KY 40207	Underground mines, quarries, plants.	Various.
Reed Crushed Stone Co	Box 35 Gilbertsville, KY 42044	Quarry and plant	Livingston.
Rogers Group Inc	Box 310 Shepherdsville, KY 40165	Quarries and plants.	Bullitt, Christian, Grayson, Oldham.
Three Rivers Rock Co	Box 218 Smithland, KY 42081	Quarry and plant	Livingston.
Vermiculite:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Campbell.

[1] Also clays.
[2] Also stone.
[3] Also sulfur.

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The Mineral Industry of Louisiana

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Louisiana Geological Survey for collecting information on all nonfuel minerals.

By James R. Boyle[1] and Charles G. Groat[2]

The value of Louisiana's nonfuel mineral production in 1987 was $424.2 million, a decrease of $22.6 million, the second straight year of declining values. The State continued to lead the Nation in production of salt and shell, was second in Frasch sulfur and fifth in sulfur recovered from oil refineries. Salt and Frasch sulfur remained the predominant nonfuel mineral commodities produced in Louisiana.

Table 1.—Nonfuel mineral production in Louisiana[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	334	$7,017	332	$7,670	357	$9,192
Gem stones	NA	e1	NA	1	NA	1
Salt ---------- thousand short tons	12,271	137,273	11,608	103,611	12,498	108,999
Sand and gravel:						
Construction ---------- do	e15,000	e48,000	14,292	46,134	e12,200	e43,600
Industrial ---------- do	267	3,838	256	4,225	289	3,997
Stone (crushed)[3] ---------- do	4,820	25,956	e5,400	e25,300	4,390	36,514
Sulfur (Frasch) -- thousand metric tons	1,698	W	1,602	W	1,458	W
Combined value of cement (masonry (1985, 1987), and portland), gypsum (1985, 1987), lime, stone (crushed miscellaneous), and values indicated by symbol W ----------	XX	298,501	XX	259,857	XX	221,918
Total ----------	XX	520,586	XX	446,798	XX	424,221

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Louisiana in 1986, by parish[1]

Parish	Minerals produced in order of value
Allen	Sand and gravel.
Ascension	Salt.
Assumption	Do.
Beauregard	Sand and gravel.
Bienville	Clays.
Caddo	Do.
Calcasieu	Salt.
Cameron	Do.
Catahoula	Sand and gravel.
East Baton Rouge	Do.
East Feliciana	Do.
Iberia	Salt.
Jefferson	Sulfur, salt.
Jefferson Davis	Sand and gravel.
Lafayette	Do.
Lafourche	Salt.
LaSalle	Sand and gravel.
Livingston	Do.
Morehouse	Do.
Natchitoches	Clays.
Orleans	Cement.
Ouachita	Sand and gravel.
Plaquemines	Sulfur, salt.
Pointe Coupee	Clays.
Rapides	Sand and gravel.
Red River	Do.
St. Bernard	Do.
St. Helena	Do.
St. Martin	Salt, sand and gravel.
St. Mary	Salt.
St. Tammany	Sand and gravel, clays.
Tangipahoa	Sand and gravel.
Union	Do.
Vermilion	Do.
Vernon	Do.
Washington	Do.
Webster	Do.
West Feliciana	Do.
Undistributed[2]	Stone (crushed), lime, gem stones.

[1]No production of nonfuel mineral commodities was reported for parishes not listed.
[2]Data not available by parish for minerals listed.

Trends and Developments.—The Louisiana economy, stagnant since 1982, improved while the unemployment rate dropped from nearly 15% in January to slightly less than 10% in December. However, nearly all mineral-related sectors decreased in employment: Mining dropped nearly 10%; construction, 8%; and stone, clay, and glass dropped more than 5%.

Mineral-related industries producing anhydrous ammonia, chlorine, liquid hydrogen, and sulfuric acid expanded facilities at a cost of $24 million. One new facility under construction, a calcium chloride plant at Norco valued at $10 million, was scheduled for completion in 1988.

Severance tax receipts for 1987, as reported by the Louisiana Department of Revenue, totaled slightly over $3.0 million, down from $3.4 million in 1986. Minerals taxed included brine ($54,000), gravel ($406,000), salt ($275,000), sand ($623,000), shell ($254,000), stone ($6,000), and sulfur ($1.4 million). Only brine and sand had increased values; the remaining commodities had decreased values from those of 1986.

Minerals were the basic cargo handled at the port at Burnside. The facility handled 3.6 million short tons of material in 1987, up slightly from 3.5 million tons in 1986. Minerals handled included alumina, bauxite, cement, chrome, coal, coke, ferroalloys, fluorspar, iron ore, manganese ore, pig iron, rutile, vermiculite, and zircon. Major minerals shipped through the port at Lake Charles included barite, cement, and crushed stone.

Freeport-McMoRan Inc. purchased Agrico Chemicals Co. for $250 million; the purchase included Agrico's fertilizer facilities at Donaldsonville, LA. Freeport constructed a $3 million pilot plant, at its Convent facility, to convert phosphogypsum, a waste product, into sulfuric acid and synthetic aggregate. The pilot plant was expected to be operational in 1988.

Legislation and Government Programs.—A joint Federal-State $45 million project to deepen the Mississippi River from 40 to 45 feet was begun in July. The first phase will deepen the channel from New Orleans to Donaldsonville and will take a year and a half. The second phase will deepen the river to Baton Rouge. Deepening of the channel will allow greater tonnages of mineral raw materials to be imported through the use of larger ships.

The Mineral Resources Institute of the Louisiana State University received a grant from the U.S. Bureau of Mines under title III of Public Law 95-87. The law was designed to encourage the training of mining engineers and other scientists involved in mineral-related studies.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Output of portland cement increased while construction activities decreased. A relatively small amount of masonry cement was produced after no output in 1986. Lone Star Industries Inc., the only cement producer in Louisiana, installed a high-capacity conveyor system capable of unloading 600,000 short tons per year at its New Orleans terminal. Major uses for portland cement were ready-mixed concrete, concrete products, building materials, and highway construction. Imports of cement and clinker amounted to 1,600,000 short tons.

Clays.—Common clay was the only clay produced in Louisiana and was mined by five companies at seven mines in five parishes. Output increased slightly, and unit prices increased from $23.10 per short ton in 1986 to $25.75 per ton in 1987. Major use was in the manufacture of lightweight aggregates for use in concrete block and structural concrete. With demand tied closely to construction activities, output remained at a relatively low level. CRH PLC of Dublin, Ireland, purchased Big River Industries Inc. for $22 million. Big River was a major producer of lightweight aggregate with manufacturing plants in Alabama, Georgia, and Louisiana. The Baton Rouge facility marketed its products in a 1 \-State area in the Southeast and barge- material to Minnesota and Illinois.

Lime.—Output of lime remained relatively low while production decreased slightly for hydrated lime, but increased for quicklime; total output increased. USG Corp. produced both quicklime and hydrated lime from shells at its facility in New Orleans; Dravo Lime Co. also produced both quicklime and hydrated lime at its plant in Amelia. Output was used in water purification and softening, road stabilization, and petrochemicals.

Salt.—Louisiana continued as the leading salt producer in the Nation with approximately one-third of the Nation's output. Production increased 7.7%, while unit value decreased 2.4%. Ten companies recovered salt at 11 operations in 9 parishes. Three operations were underground mines, and the remaining ones were solution mines.

Markets for salt remained stable at two companies in the State, PPG Industries Inc. and The Dow Chemical Co. Both expanded their chlorine facilities. Chlorine and caustic soda were the largest domestic markets for salt, using about one-half of the Nation's output.

Sand and Gravel.—Louisiana produced both construction and industrial sand and gravel in 1987; total output decreased.

Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates. Estimates of output of construction sand and gravel show a decrease from that of 1986. The output was tied to the relatively depressed economic conditions in the State and decreased construction activities. Most operations maintained output at less than capacity, depending on proximity to and type of construction activities. Ideal Basic Industries acquired Braswell Sand and Gravel Co. Inc. of Shreveport and its tow subsidiaries, which served the ready-mix, aggregate, concrete pipe, and concrete block markets in the area.

Industrial.—Three companies produced industrial sand from four parishes with more output than in 1986; unit values, however, decreased. Markets in the foundry industry remained firm, while those in the glass industry were weak.

Stone (Crushed).—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates. Reported production of crushed stone in 1987 decreased from that estimated for 1986; unit prices increased. Shell accounted for over 90% of the State's total crushed stone output; Louisiana remained the leading producer of shell nationally. Three companies produced shell in Orleans and St. Mary Parishes at five operations. Anhydrite was mined at one quarry in Winn Parish. Crushed stone was used primarily for coarse and fine aggregates, cement, and lime manufacture; anhydrite was used mainly as a road base.

Environmental attacks on the shell industry continued while the U.S. Corps of Engineers completed its environmental impact statement on the effects of shell dredging. At yearend, the State renewed dredging

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leases, although the corps had not decided to allow continued dredging of shells. In a suit filed by the Sierra Club, a New Orleans district court declared that the State's leases with shell dredging companies were invalid because bid laws were not followed; the action was appealed to the circuit court of appeals with no decision by yearend. To fill the possible void if shell dredging were stopped, several companies were developing options to supply the Louisiana market. Vulcan Materials formed a joint venture with Mexico's Grupo ICA to quarry stone in the Yucatan Peninsula to ship to gulf coast markets; two of the major markets are Lake Charles and New Orleans.

Ideal Basic Industries Inc. and Dravo Basic Materials Co. were also studying the feasibility of importing crushed stone from Mexico and the Dominican Republic into Louisiana markets. Dravo, in an agreement with Cyprus Minerals Co., acquired Three Rivers Rock Co. and Louisiana Limestone Aggregates Inc. Three Rivers has a 4- to 5-million-short-ton-per-year quarry in Kentucky, while Louisiana Limestone has distribution yards in Baton Rouge, Houma, Knotz Springs, Lake Charles, and Morgan City.

Table 3.—Louisiana: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	14	97
Coarse aggregate: Graded road base or subbase	542	7,012
Special: Other unspecified[2]	3,834	29,405
Total	4,390	36,514

[1]Includes shell and sandstone; miscellaneous stone withheld to avoid disclosing company proprietary data.
[2]Includes unpaved road surfacing, production reported without a breakdown by end use, and estimates for nonrespondents.

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Sulfur.—Louisiana ranked second nationally in output of Frasch sulfur and fifth in recovered elemental sulfur. Sulfur shipments decreased for the third straight year, but, in terms of value, remained the State's leading nonfuel mineral. Output remained at a relatively low level because of the weak demand for phosphate fertilizers. Freeport Minerals Co. operated its Garden Island Bay facilities at the mouth of the Mississippi and its Grand Isle Mine 6 miles offshore; its Caminada Pass Mine, another offshore mine, was scheduled to produce sulfur in early 1989. Freeport utilizes about 80% of its output at its fertilizer plants in Convent and Donaldsonville; most of the remainder was used by the fertilizer industry at Tampa, FL.

The U.S. Department of the Interior planned a sulfur lease sale on tracts in the central and western regions of the Outer Continental Shelf in the Gulf of Mexico early in 1988.

Nine oil companies recovered elemental sulfur from nine refineries in seven parishes. Output was 536,000 metric tons valued at $51.1 million, compared with 527,000 tons valued at $57.4 million in 1986.

Table 4.—Louisiana: Sulfur produced and shipped from Frasch mines

(Thousand metric tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1983	1,286	1,643	W
1984	1,937	2,007	W
1985	2,071	1,698	W
1986	1,579	1,602	W
1987	1,369	1,458	W

W Withheld to avoid disclosing company proprietary data.

Other Industrial Minerals.—Imported and domestic barite was crushed and ground at eight plants in Louisiana for use in oil and gas drilling; output increased over that of 1986. Slightly more than 200,000 short tons of barite was imported through the port at Lake Charles, most of which was from China. Allied Signal Corp. and Texas United Chemical Corp. produced synthetic calcium chloride using hydrochloric acid and limestone at plants in Baton Rouge and Lake Charles; production and value increased. Synthetic calcium chloride was used in concrete setup, dust control, oil and gas drilling, road deicing, and other uses. TETRA Resources Inc. started construction of a $10 million calcium chloride pellet facility. The plant at Norco was expected to be in operation by mid-1988. Louisiana was one of two States with reported production of synthetic calcium chloride. Agrico Chemical Co. at Donaldsville and Freeport Chemical Co. at Uncle Sam operated fluosilicic acid facilities during the year. Freeport-McMoRan purchased Agrico's facility during the year. National Gypsum Co. in Jefferson Parish and USG Corp. in Orleans Parish produced calcined gypsum from crude material shipped into the State. Calcined gypsum output and value increased over that of 1986. Total annual capacity for anhydrous ammonia was more than 7 million short tons or more than 40% of national capacity. Of the 43 domestic producers of anhydrous ammonia, 14 had facilities in Louisiana. American Cyanamid Co., Westwego, expanded facilities at a cost of more than $6 million; completion was expected by mid-1988. Crude perlite was expanded by Filter-Media Co. Inc. of Louisiana at its facilities in Reserve, St. John the Baptist Parish, from material shipped into the State. Output of expanded perlite increased while unit values increased. The perlite was used as a filter aid, for insulation, and in concrete aggregate. Vermiculite was exfoliated by W. R. Grace & Co. at its plant in New Orleans. Principal end uses were in concrete and plaster aggregate, horticulture, loose fill insulation, and block insulation.

METALS

Aluminum.—Louisiana remained 1 of 17 States capable of producing aluminum; the State's facilities have been idle since 1983. In 1987, Kaiser Aluminum & Chemical Corp. wrote off the remaining 105,000 metric tons per year of capacity at its closed Chalmette smelter.

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Ormet Corp.'s alumina refinery at Burnside remained closed for the second straight year. Ohio River Associates, the owner of Ormet, stated that, if certain employee concessions were made, the plant would reopen.

Iron and Steel.—Bayou Steel Corp. operated the only minimill in Louisiana at LaPlace. The minimill had a capacity of 700,000 short tons with a rolling capacity of 400,000 tons. Because of inexpensive barge transportation costs, Bayou's market area extended to Chicago, IL, and Pittsburgh, PA.

Nickel.—AMAX Inc. operated its metal recovery facility at Braithwaite. After an 8-week work stoppage, the refinery resumed operations late in the year. Annual rated capacity was 3 million pounds of molybdenum, 4 million pounds of vanadium pentoxide, 40 million pounds of nickel cobalt residues, and 24 million pounds of aluminum trihydrite.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.
[2]State geologist, Louisiana Geological Survey, Baton Rouge, LA.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	Parish
Aluminum:			
Kaiser Aluminum & Chemical Corp	Box 1600 Chalmette, LA 70043	Plant	St. Bernard.
Cement:			
Lone Star Industries Inc	515 W. Greens Rd. Houston, TX 77067	do	Orleans.
Clays:			
Athens Brick Co. Inc	Box 70 Athens, TX 75751	Mines and plant	Caddo.
Big River Industries Inc	Box 66377 Baton Rouge, LA 70806	Mine and plant	Pointe Coupee.
Gypsum:			
National Gypsum Co	Box 128 Westwego, LA 70094	Plant	Jefferson.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Orleans.
Lime:			
Dravo Lime Co	One Gateway Center 7th Floor Pittsburgh, PA 15222	do	St. Mary.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Orleans.
Salt:			
Domtar Chemicals Inc., Shifto Salt Div	4825 North Scott Shiller Park, IL 60176	Underground mine	St. Mary.
The Dow Chemical Co	Midland, MI 48640	Brine wells	Iberville.
International Salt Co	Clarks Summit, PA 18411	Underground mine	Iberia.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	do	Do.
PPG Industries Inc	Box 1000 Lake Charles, LA 70604	Brine wells	Calcasieu.
Sand and gravel:			
Gifford-Hill & Co. Inc	Box 6615 Shreveport, LA 71136	Dredges, pits, plants.	Jefferson Davis, Rapides, Tangipahoa, Webster.
Louisiana Sand and Gravel Co	Box 963 Baton Rouge, LA 70821	Dredge and plant	St. Helena.
Standard Gravel Co. Inc	Route 7, Box 53 Franklinton, LA 70438	Dredges and plants	St. Tammany and Washington.
Texas Industries Inc	Box 5472 Alexandria, LA 71301	Dredges, pits, plants.	Beauregard, Grant, La Salle, Ouachita, Rapides, St. Tammany.
Stone (crushed):			
Pontchartrain Dredging Corp	Box 8005 New Orleans, LA 70182	Quarry and plant	Winn.
Southern Industries Corp	Box 2068 Mobile, AL 36652	Dredges	Orleans and St. Mary.
Winn Rock Inc	Box 790 Winnfield, LA 71483	Quarry and plant	Winn.
Sulfur:			
Native:			
Freeport Minerals Co	200 Park Ave. New York, NY 10166	Frasch process	Jefferson and Plaquemines.
Recovered:			
Cities Service Oil Co	Box 300 Tulsa, OK 74102	Refinery	Calcasieu.
Exxon Co. U.S.A.	Box 551 Baton Rouge, LA 70821	Plant	East Baton Rouge.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Orleans.

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The Mineral Industry of Maine

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Maine Geological Survey for collecting information on all nonfuel minerals.

By Donald K. Harrison,[1] Walter Anderson,[2] and Michael E. Foley[3]

The value of nonfuel mineral production in Maine in 1987 was $65.5 million, a $12.6 million increase over that of 1986. The increase was primarily the result of increased consumption of construction aggregates, notably crushed stone, cement, and construction sand and gravel. Cement continued to account for the largest portion of the State's mineral commodity value, followed by construction sand and gravel, crushed stone, and dimension stone.

Table 1.—Nonfuel mineral production in Maine[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	50	$100	46	$90	W	W
Gem stones	NA	e400	NA	200	NA	$1,172
Sand and gravel (construction) thousand short tons	e7,200	e18,000	8,572	22,843	e8,600	e22,100
Stone:						
Crushed ---------- do	1,459	5,114	e1,600	e4,400	2,010	7,532
Dimension ---------- do	W	W	W	W	8	5,924
Combined value of cement, garnet (abrasive), peat (1986), and values indicated by symbol W	XX	17,494	XX	25,326	XX	28,729
Total	XX	41,108	XX	52,859	XX	65,457

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Maine in 1986, by county[1]

County	Minerals produced in order of value
Androscoggin	Sand and gravel, clays.
Aroostook	Sand and gravel (construction).
Cumberland	Sand and gravel (construction), clays.
Franklin	Sand and gravel (construction), abrasives.
Hancock	Sand and gravel (construction).
Kennebec	Do.
Knox	Cement, sand and gravel (construction).
Lincoln	Sand and gravel (construction).
Oxford	Do.
Penobscot	Do.
Piscataquis	Do.
Sagadahoc	Do.
Somerset	Do.
Waldo	Sand and gravel, peat.
Washington	Sand and gravel (construction).
York	Do.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—In 1987, construction activity in Maine remained strong and was expected to continue into 1988. Growth of all contract construction was up nearly 60% since 1983, more than double the national rate of 26%. Much of this growth can be attributed to increased highway maintenance, a strong housing market, and the many hydroelectric projects being constructed on Maine's rivers. As a result of these construction increases, output of most construction mineral commodities increased in 1987. Increases in quantity were reported for crushed stone (26%) and cement (15%). Construction sand and gravel production, which remained virtually unchanged from that of 1986, was the highest reported since 1980.

Although there was no reported peat production in Maine in 1987, the State is expected to have North America's first peat-fired electric plant. Groundbreaking ceremonies for a 22,800-kilowatt powerplant were held in July at Deblois, with construction scheduled to be completed by the end of 1988. Fuel for the plant will be harvested from the surrounding 1,200-acre Denbo Heath peat bog. The $51 million project was developed by Peat Products of America Inc., Bangor; Ateliers de Constructions Electriques de Charleroi, Belgium; and Transco Energy Co., Houston, TX. Boston Edison Co. will purchase the plant's electrical output, which will serve about 15,000 residential and commercial customers.

Legislation and Government Programs.—Several laws were passed in 1987 that addressed solid and hazardous waste disposal, ground water protection, and radon, a naturally occurring, radioactive gas believed to be a major cause of lung disease in the United States. Chapter 517 was signed in June to reorganize the Solid Waste Law and to ensure safe management, recycling, and disposal of solid wastes. Chapter 65, Private and Special Law, also became effective in June. The law provided funding to accelerate collection of geologic information relating to hazardous waste disposal and geologic resources and hazards assessment. With regard to low-level radioactive waste, two bills were passed in 1987. Chapter 530 created the Maine Low-Level Radioactive Waste Authority, and chapter 233 coordinated the review process from low-level radioactive waste between the Department of Environmental Protection and the Maine Land Use Regulation Commission. Other bills passed included chapter 491, which provided a comprehensive protection plan for the State's ground water resources; and Resolve Law, chapter 54, which directed that a comprehensive examination of the health threat of radon and its derivitives be undertaken.

The Maine Geological Survey (MGS), a bureau of the Department of Conservation, continued to map, interpret, and publish geologic information and provide technical assistance to the minerals industry, planning and regulatory agencies, and the general public. During 1987, the MGS conducted work on bedrock and surficial geological mapping, hydrology, and marine geology programs and earthquake monitoring. The MGS also continued updating and expanding the USGS Mineral Research Data System (MRDS) file for the State of Maine. MRDS is a computerized mineral data storage and analysis system.

The issue of radioactive waste disposal again received much attention in 1987.

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With the support of a special legislative appropriation, the MGS conducted extensive geological investigations of the State's two high-level nuclear waste candidate sites. These investigations consisted of field mapping and geophysical studies in the Bottle Lake Complex of eastern Maine and photolineament analyses of both Bottle Lake and the Sebago batholith in southwestern Maine.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Maine continued to be the only New England State that produced cement. Dragon Cement Co. produced both portland and masonry cement at a plant in Thomaston, Knox County. Production of portland cement increased almost 16% in 1987; masonry cement production remained essentially the same. Cement was also shipped into the State from out-of-State sources. Shipments of portland cement totaled 361,000 short tons, and masonry cement totaled 12,000 short tons. Most of the cement was utilized by ready-mixed concrete companies and concrete production manufacturers.

Clays.—Morin Brick Co., the State's only producer of clay, mined common clay at operations in Androscoggin and Cumberland Counties, primarily for use in brick manufacture. In September, the company applied to the Auburn Planning Board for a permit to excavate an additional 49 acres over a 50-year period in Auburn. The company needed the permit to assure a continuing supply of raw material for its brick plant.

Garnet.—Industrial Garnet Extractives Inc. (IGE) was one of four garnet producers in the United States. IGE operated a mine and plant near Rangeley, Oxford County, and produced a wide range of garnet products, which were used mostly in sandblasting and water filtration.

Gem Stones.—Maine ranked fifth in the Nation in the value of natural semiprecious and gem-quality specimens found. The November-December issue of Rocks and Minerals[4] was devoted entirely to Maine's minerals and mineral localities.

Perlite (Expanded).—Crude perlite shipped in from New Mexico was expanded by the Chemrock Corp. at a plant in Rockland, Knox County. The expanded perlite was sold locally, primarily as a filter aid.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

The estimated output of 8.6 million short tons of construction sand and gravel remained essentially the same as that of 1986. Leading counties in order of output were York, Cumberland, Aroostook, and Penobscot.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone production and value in 1987 increased 26% and 71%, respectively. These increases reflected the continuing strong demand by the construction industry, the primary users of aggregate. The counties of Cumberland, Knox, and Penobscot accounted for the majority of stone produced. Types of stone quarried were limestone, marl, traprock, and quartzite. Leading uses were for cement manufacture, concrete aggregate, and railroad ballast.

Table 3.—Maine: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate, graded. Concrete aggregate, coarse	436	1,143
Other miscellaneous[2]	770	1,465
Other unspecified[3]	804	4,924
Total	2,010	7,532

[1]Includes limestone, quartzite, traprock, and marl.
[2]Includes agricultural limestone, poultry grit and mineral food, and cement manufacture.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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Dimension.—New England Stone Industries Inc. quarried dimension granite at Crotch Island, Hancock County. In 1987, output totaled nearly 8,000 short tons valued at $5.9 million. Most of the stone was used for veneer, flagging, curbing, and rough blocks.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]State geologist and director, Maine Geological Survey, Augusta, ME.
[3]Resource administrator, Maine Geological Survey, Augusta, ME.
[4]Rocks and Minerals. V. 62, No. 6., Nov.-Dec. 1987, pp. 382-467.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Dragon Cement Co.[1]	Box 191 Thomaston, ME 04861	Quarry and plant	Knox.
Clays:			
Morin Brick Co	Mosher Rd. Gorham, ME 04038	Pits and plants	Androscoggin and Cumberland.
Garnet:			
Industrial Garnet Extractives Inc	Box 56A West Paris, ME 04289	Mill	Oxford.
		Quarry	Franklin.
Perlite (expanded):			
Grefco Inc	Box 177 Thomaston, ME 04861	Plant	Knox.
Sand and gravel (construction):			
Harry C. Crooker & Sons Inc	R.F.D. 4, Old Bath Rd. Brunswick, ME 04011	Pits and plants	Lincoln and Sagadahoc.
Dragon Products Co	Box 191 Thomaston, ME 04861	----do	Androscoggin, Franklin, Hancock, Somerset.
R. J. Grondin & Son	Rural Route 4, Box 65 Gorham, ME 04038	Pits	Cumberland and York.
Lane Construction Corp.[1]	Box 627 Presque Isle, ME 04769	----do	Aroostook, Penobscot, Waldo, Washington.
Madawaska Brick & Block Co	R.D. 1, Box 250 Madawaska, ME 04765	Pit and plant	Aroostook.
Maine Department of Transportation.	Augusta, ME 04333	Pits and plants	Androscoggin, Aroostook, Cumberland, Franklin, Knox, Lincoln, Oxford, Penobscot, Piscataquis, Sagadahoc, Somerset, Waldo, York.
Portland Sand & Gravel Co. Inc	Gray Rd. Cumberland, ME 04021	Pit and plant	Cumberland.
Tilcon Inc	Box 209 Fairfield, ME 04937	Pits and plants	Cumberland, Somerset, York.
White Bros. Inc	95 Warren Ave. Westbrook, ME 04092	Pit and plant	Cumberland.
Stone:			
Crushed:			
Blue Rock Industries	58 Main St. Westbrook, ME 04092	Quarries and mill	Cumberland and Kennebec.
The Cook Concrete Co	960 Ocean Ave. Portland, ME 04103	Quarry and mill	Cumberland.
Dragon Products Co	Box 191 Thomaston, ME 04861	Quarries	Knox.
Lane Construction Corp	Box 103 Bangor, ME 04401	----do	Aroostook and Penobscot.
Dimension:			
New England Stone Industries Inc.	Providence Pike Smithfield, RI 02917	Quarry	Hancock.

[1]Also stone.

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The Mineral Industry of Maryland

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Maryland Geological Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Maryland in 1987 was $345 million. Output of all of the State's mineral commodities continued to increase, boosting value to its highest mark in State history.

Table 1.—Nonfuel mineral production in Maryland[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) thousand short tons	W	W	1,785	$89,799	1,829	$90,020
Clays do.	[2]336	[2]$1,647	[2]362	[2]1,757	383	1,940
Gem stones	NA	[e]2	NA	5	NA	5
Lime thousand short tons	10	608	10	546	9	486
Sand and gravel (construction) do.	[e]17,000	[e]58,000	18,173	86,925	[e]19,600	[e]92,900
Stone:						
Crushed do.	24,406	98,584	[e]26,400	[e]126,000	30,136	151,579
Dimension do.	18	1,218	[e]21	[e]1,286	23	1,516
Combined value of cement (masonry), clays (ball clay, 1985-86), peat, sand and gravel (industrial), and value indicated by symbol W	XX	98,215	XX	7,027	XX	6,688
Total	XX	258,274	XX	313,345	XX	345,134

[e]Estimated. — Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by preducers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.

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Table 2.—Nonfuel minerals produced in Maryland in 1986, by county[1]

County	Minerals produced in order of value
Anne Arundel	Sand and gravel (construction).
Baltimore	Sand and gravel (construction), clays.
Baltimore City	Sand and gravel.
Calvert	Do.
Caroline	Do.
Carroll	Cement, clays.
Cecil	Sand and gravel (construction).
Charles	Do.
Dorchester	Do.
Frederick	Cement, clays, lime.
Garrett	Sand and gravel (construction), peat.
Harford	Sand and gravel (construction).
Kent	Clays.
Prince Georges	Sand and gravel (construction), clays.
Queen Annes	Sand and gravel (construction).
Saint Mary's	Do.
Somerset	Do.
Washington	Cement, clays.
Wicomico	Sand and gravel.
Worcester	Do.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—Beginning in 1983 and continuing through 1987, demand from the construction industry as a result of the State's expanding economy and increasing population boosted mineral production to unprecedented levels. Maryland's combined output of crushed stone and sand and gravel increased by 100% or 24.8 million short tons from 1982 to 1987. The State's population increased by 7% during these 5 years; and the population density (persons per square mile) increased from 422 to 461, fifth highest in the Nation.

This sustained period of above-average mineral production, coupled with a growing populace, exacerbated the situation between environmental and mining concerns. The mining industry, when planning to expand or develop operations, was typically required to address local concerns about the impact of such actions. Balancing environmental considerations and natural resources development in land-use planning has become increasingly difficult in Maryland; and, in many cases, the decision has been finalized only through the courts.

Generally, expanding urbanization also restricts resource availability when, because of inadequate land-use planning, structures are built near or atop mineral deposits. The consequences are increases in both consumer cost and environmental damage while creating or continuing adversarial relationships between mineral producers and the market community that uses the mineral products.[2]

Legislation and Government Programs.—The Maryland Legislature responded to oil exploration in Chesapeake Bay and the Potomac River by passing a series of bills regulating drilling in the State. These bills prohibited drilling for oil or gas in Chesapeake Bay and its tributaries, increased bond requirements and liability insurance for companies drilling for oil and gas in the State, and required an environmental impact statement for oil and gas projects sited on State lands. The legislation was enacted after two major U.S. oil companies conducted tests for oil using sonar equipment.

The Maryland Geological Survey (MGS) conducted geologic and mineral-related studies at facilities in Baltimore. In 1987, the MGS published a directory of mineral producers in the State that listed locations of more than 200 active mining operations.[3]

Maryland created a new government agency primarily responsible for environmental protection. The Maryland Department of the Environment (MDE) assumed the authority for air, water, waste, radiation, and noise control programs previously handled by the Office of Environmental Programs, which was abolished. Department of Natural Resources (DNR) responsibilities for oil control, erosion and sediment control, and stormwater management were also transferred to the MDE.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Three mineral commodities—portland cement, construction sand and gravel, and crushed stone—accounted for about 97% of the value of mineral production in Maryland in 1987.

Cement.—Demand for portland cement remained strong for the fourth consecutive year. The State's four plants operated at about 95% of capacity.

Lehigh Portland Cement Co., Union Bridge, requested permission from the DNR Water Resources Administration to pump ground water from a new limestone quarry site near New Windsor. Ground water must be removed before Lehigh can mine the limestone, which is used in cement manufacture. Because of concern by local residents that ground water removal will affect well water supplies or cause sinkholes, the DNR, in cooperation with Lehigh, began a study late in the year to determine the impacts associated with quarry development. Results from the study were not expected until mid-1988.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Output of construction sand and gravel reached a record-high level for the third consecutive year in 1987. Nationally, Maryland ranked 15th in the production of sand and gravel. The price of sand and gravel in Maryland was 30% above the U.S. average in 1987 and second highest in the Nation at $4.60 per short ton (plant f.o.b.).

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Maryland produced about 30.1 million short tons of crushed stone in 1987, the State's highest total ever and the fourth consecutive year of output in excess of 22 million tons. Previously, Maryland's output of crushed stone had peaked in 1979, when 21.6 million tons was produced. During the 4-year period of record-setting production, the State averaged 25 to 30 expansions of existing operations each year, according to DNR's Division of Surface Mining.[4]

Table 3.—Maryland: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	856	4,501
Riprap and jetty stone	919	4,399
Filter stone	92	479
Coarse aggregate, graded:		
Concrete aggregate, coarse	2,610	11,593
Bituminous aggregate, coarse	992	4,585
Bituminous surface-treatment aggregate	573	3,571
Railroad ballast	104	616
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	591	2,353
Screening, undesignated	466	2,440
Coarse and fine aggregates:		
Graded road base and subbase	1,697	8,712
Unpaved road sufacing	502	3,142
Crusher run or fill or waste	4,283	17,890
Other construction	154	565
Chemical and metallurgical: Cement manufacture	2,660	7,914
Special:		
Whiting or whiting substitute	40	4,000
Other fillers and extenders	100	6,000
Other miscellaneous[2]	61	6,089
Other unspecified[3]	13,396	61,733
Total	30,136	[4]151,579

[1]Includes limestone, granite, sandstone, quartzite, shell, traprock, and other miscellaneous stone.
[2]Includes lime manufacture and paper manufacture.
[3]Inclues production reported with a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

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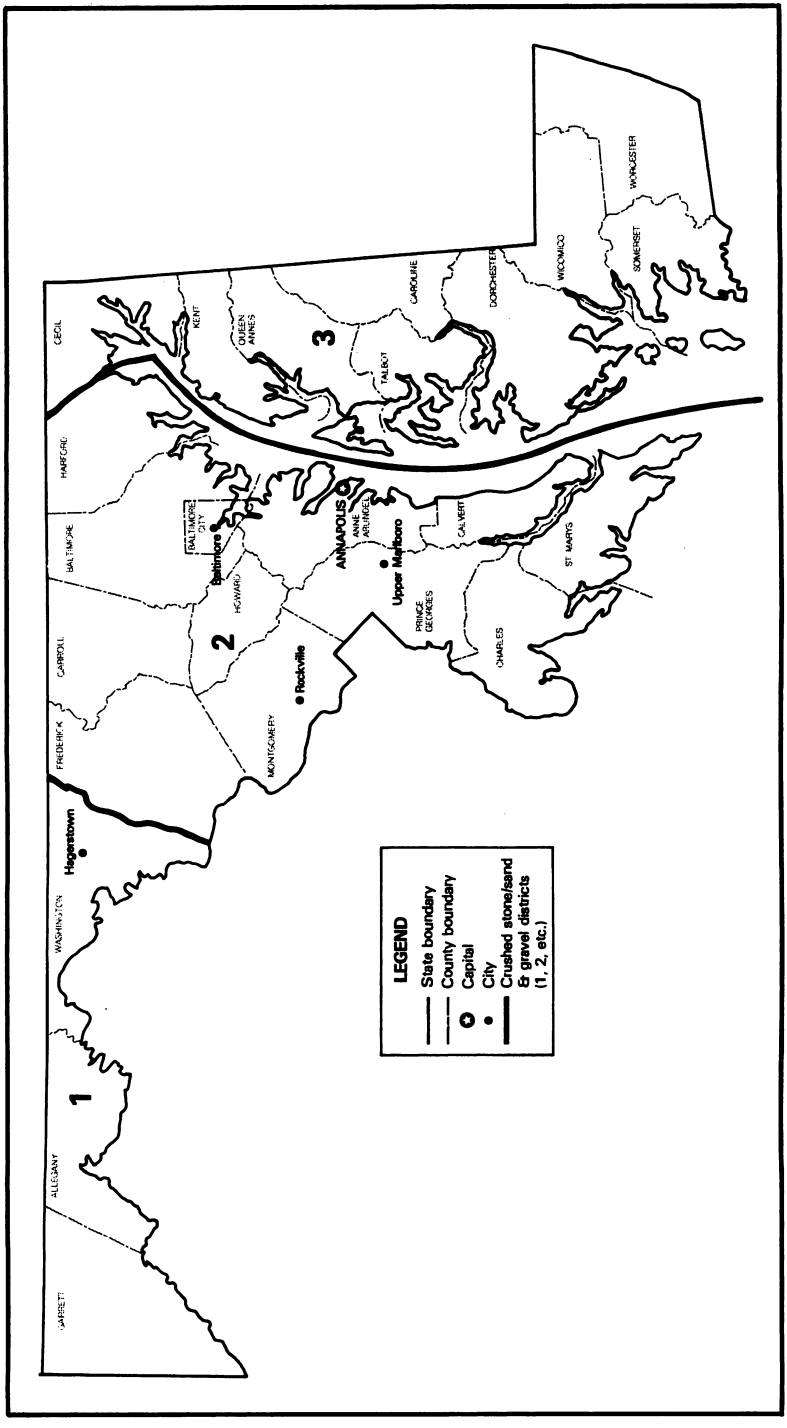

Figure 1.—Aggregate-producing districts in Maryland.

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Table 4.—Maryland: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	W	W	1,190	5,950	W	W
Coarse aggregate, graded[2]	W	W	2,578	12,306	W	W
Fine aggregate (-3/8)[3]	152	718	906	4,076	--	--
Coarse and fine aggregates[4]	W	W	3,500	15,949	W	W
Other construction	2,275	8,848	135	500	3,104	16,499
Chemical and metallugical[5]	737	([6])	1,942	([7])	--	--
Special[8]	--	--	220	17,000	--	--
Other miscellaneous	3	1,804	--	--	--	--
Other unspecified[9]	405	2,075	12,480	61,773	510	4,083
Total[10]	3,571	13,444	22,950	117,552	3,614	20,583

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregates, and railroad ballast.
[3]Includes stone sand (bituminous mix or seal) and fine aggregate (screening).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Includes cement manufacture and lime manufacture.
[6]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[7]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[8]Includes whiting or whiting substitute, other fillers or extenders, paper manufacture, and roofing granules.
[9]Includes production reported with a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

The openings and expansions of quarries by producers to meet the demands of the construction industry have, been opposed, in many cases by citizen groups. In some instances, this forced producers to locate farther from markets and increased haulage costs, the price of crushed stone, and ultimately, the cost of construction.

In 1987, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use date for crushed stone produced in the Maryland districts depicted in figure 1.

Other Industrial Minerals.—Production of ball clay at a small operation in White Marsh ceased in late 1986; common clay used in brickmaking was produced at seven pits in 1987. The State's only lime producer, S. W. Barrick & Sons Inc., Woodsboro, was sold and announced plans to close the lime manufacturing plant in 1988. Laurel Sand & Gravel Inc., the new owner, retained the former company name and intends to mine high-calcium limestone at the site in 1988. Two of the State's four portland cement producers also manufactured masonry cement at plants in Hagerstown and Union Bridge. One company produced industrial sand at a pit in Joppa, and one firm mined peat at a bog near Accident.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]Beeby, D. J. Aggregate Producers. Min. Eng., v. 40, No. 1, Jan. 1988, pp. 42-45.
[3]Brooks, J. R. Directory of Mineral Producers in Maryland—1986, MD Geol. Surv. Inf. Circ. 45, 1987, p. 56.
[4]Evening Sun (Baltimore). Progress Brings Road and Quarries. June 27, 1987, p. 5.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Eastalco Aluminum Co. (Alumax Inc.).	5601 Manor Woods Rd. Frederick, MD 21701	Reduction plant	Frederick.
Cement:			
Portland:			
Coplay Cement Co., (Société des Ciments Français).	4120 Buckeystown Pike Lime Kiln, Box D Frederick, MD 21701	Quarry and plant.	Do.
Portland and masonry:			
Independent Cement Corp. (St. Lawrence Cement Inc	Box 650 Hagerstown, MD 21740	----do-----	Washington.
Lehigh Portland Cement Co. (Heidelberger Zement AG).	Box L Union Bridge, MD 21791	----do-----	Carroll.
Slag:			
Blue Circle-Atlantic[1] (Blue Circle Industries PLC).	Box 6687 Sparrows Point, MD 21219	Plant (slag cement).	Harford.

See footnote at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays:			
Common clay and shale:			
Baltimore Brick Co. (Merry Co.)	9801 Rocky Ridge Rd. Rocky Ridge, MD 21778	Pits and plants	Baltimore and Frederick.
Maryland Clay Products Inc. (Borden Brick & Tile Co.).	7100 Muirkirk Rd. Beltsville, MD 20705	____do_____	Frederick and Prince Georges.
Victor Cushwa & Sons Inc	Clearspring Rd. & Route 68N Box 160 Williamsport, MD 21795	Pit and plant	Washington.
Gypsum:			
Byproduct:			
SCM Corp., SCM Pigments Div.	3901 Glidden Rd. Baltimore, MD 21226	Plant	Baltimore.
Calcined:			
National Gypsum Co., Gold Bond Building Products Div.	2301 South Newkirk St. Baltimore, MD 21224	____do_____	Do.
USG Corp	500 Quarantine Rd. Box 3472 Baltimore, MD 21226	____do_____	Do.
Iron and steel:			
Bethlehem Steel Corp	Sparrows Point, MD 21219	Mill (integrated)	Do.
C. J. Langenfelder & Sons	8427 Pulaski Highway Baltimore, MD 21221	____do_____	Do.
Lime:			
S. W. Barrick & Sons Inc	Woodsboro, MD 21798	Quarry and plant.	Frederick.
Peat:			
Garrett County Peat Products	R.F.D. 1, Box 91 Accident, MD 21520	Bog and plant	Garrett.
Sand and gravel:			
Construction:			
Charles County Sand & Gravel Co. Inc.	Waldorf Industrial Center Box 548 Waldorf, MD 20601	Pits and plant	Anne Arundel, Charles, St. Marys.
Eastern Aggregates Inc	10 South River Club House Rd. Harwood, MD 20776	Pits and plants	Anne Arundel and Prince Georges.
Inland Materials Inc	4714 St. Barnabas Rd. Temple Hills, MD 20748	____do_____	Prince Georges.
Maryland Rock Industries (Florida Rock Industries Inc.).	Box 273 Leonardtown, MD 20650	Pit and plant	St. Marys.
York Building Products Co. Inc., Mason Dixon Sand & Gravel Div.	Pulaski Highway Perryville, MD 21403	____do_____	Cecil.
Industrial:			
Harford Sands Inc	Box 25 40 Fort Hoyle Rd. Joppa, MD 21085	____do_____	Harford.
Stone:			
Crushed:			
The Arundel Corp.[2]	110 West Rd. Baltimore, MD 21204	Quarries and plants.	Baltimore, Frederick, Harford.
Genstar Stone Products Inc.[3]	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	____do_____	Baltimore, Carroll, Frederick, Harford.
Maryland Materials Inc	Box W North East, MD 21901	Quarry and plant.	Cecil.
Rockville Crushed Stone Inc	Box 407 13900 Piney Meetinghouse Rd. Rockville, MD 20850	____do_____	Montgomery.
Dimension:			
Patapsco Natural Stone Quarry Inc.	Marriottsville Rd. Marriottsville, MD 21104	____do_____	Baltimore.
Stoneyhurst Quarries	Box 34463 8101 River Rd. Bethesda, MD 20817	____do_____	Montgomery.
Weaver Stone Co	15027 Falls Rd. Butler, MD 21023	____do_____	Baltimore.
Titanium dioxide (pigments):			
SCM Corp., SCM Pigments Div.	3901 Glidden Rd. Baltimore, MD 21226	Chemical plant	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	12340 Conway Rd. Beltsville, MD 20705	Plant	Prince Georges.

[1]Also common clay and shale.
[2]Also slag.
[3]Also sand and gravel.

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The Mineral Industry of Massachusetts

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Commonwealth of Massachusetts, Executive Office of Environmental Affairs, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Joseph A. Sinnott[2]

The value of nonfuel mineral production in 1987 was $176.5 million, a $42.1 million increase compared with that of 1986. The combined value of crushed stone and construction sand and gravel, the State's two leading mineral commodities, accounted for 87% of the value of mineral production. The State ranked fourth of 36 States that produced dimension stone, up from fifth in 1986.

Table 1.—Nonfuel mineral production in Massachusetts[1]

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	265	$1,388	140	$871	W	W
Gem stones	NA	W	NA	W	NA	$1
Lime ---------- thousand short tons	159	10,935	W	W	W	W
Sand and gravel:						
Construction ---------- do	e14,900	e47,500	19,200	60,464	e21,800	e75,300
Industrial ---------- do	W	W	45	739	56	922
Stone:						
Crushed ---------- do	9,354	42,881	e10,000	e50,000	14,907	78,969
Dimension ---------- do	73	13,724	e79	e14,928	77	12,747
Combined value of peat and values indicated by symbol W ----------	XX	777	XX	7,395	XX	8,583
Total ----------	XX	117,205	XX	134,397	XX	176,522

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel mineral production in Massachusetts in 1986, by county[1]

County	Minerals produced in order of value
Barnstable	Sand and gravel.
Berkshire	Lime, sand and gravel.
Bristol	Sand and gravel.
Dukes	Do.
Essex	Do.
Franklin	Do.
Hampden	Do.
Hampshire	Do.
Middlesex	Do.
Nantackuet	Do.
Norfolk	Do.
Plymouth	Sand and gravel, clays.
Worcester	Sand and gravel, peat.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—Acid rain and concern about the State's land, water, and air resources continued to be major environmental priorities. As early as 1983, a three-phase acid rain monitoring project was set up as part of a 14-year study of the effects of acid rain on the State's water bodies. The preliminary findings, released in 1986, indicated that 6% of the State's streams and ponds was acidified, an additional 16% was in critical condition, and 60% was vulnerable to the effects of acid rain. Only 18% of water bodies was determined to be protected from acidification by natural acid neutralizers such as limestone.

In 1987, at least two multimillion-dollar contracts were awarded to a Massachusetts firm to study the effects of acid rain. The Environmental Protection Agency (EPA) awarded an $8.4 million contract to Environmental Research and Technology Inc. (ERT), Concord, MA, to study acid rain deposition at 35 sites in the Eastern United States. The Electric Power Research Institute also awarded ERT a 5-year $13.5 million contract on a similar acid deposition measurement program at 23 sites in North America. The information data base from the studies will then be used by industry and government to aid in the decisionmaking process for acid rain control.

Although overall construction activity in the State was expected to level off or decline from the record levels of the previous 5 years, commercial, industrial, and residential construction in and around Boston was expected to boom. In the commercial and industrial sectors, at least two major projects had been set in motion or will be undertaken shortly. One project was the $4 billion Boston urban highway project, one of the largest type projects ever attempted. Over the next 10 years, the Massachusetts Turnpike within the city limits will be extended, a third tunnel will be dug under Boston Harbor and the Central Artery, and an elevated highway will be replaced by an underground roadway. Construction of the project itself, beginning with the tunnel, was scheduled to start in 1990, but related construction in 1989. Another multibillion-dollar project being undertaken was a $6.1 billion, 11-year cleanup of Boston Harbor, considered to be the most polluted harbor in the Nation. This project will require the construction of new sewer systems and possible construction of a new highly advanced tertiary sewage plant treatment system like the one currently in operation in Washington, DC. That plant cost $500 million in 1981. Both the highway reconstruction project and the Boston Harbor cleanup, coupled with the anticipated continuing growth of other construction in and around Boston, should create additional demand for construction aggregates, principally crushed stone, construction sand and gravel, and cement.

Anticipating an increase in demand for cement in New England, Coastal Cement Co. completed construction of a new $7 million, 40,000-ton-capacity cement storage, distribution, and packaging facility in the Port of Boston. Coastal Cement, a subsidiary of Cementos del Norte, a consortium of three Spanish cement producers, planned to distribute Spanish-produced cement throughout New England.

Legislation and Government Programs.—In September, the Massachusetts attorney general announced that Massachusetts had joined four other Northeastern States (Connecticut, New Jersey, New York, and Vermont) and the Natural Resources Defense Council in petitioning for a full review of air-quality regulations promulgated by EPA. The petition, filed in the U.S. Court of Appeals in the District of Columbia, challenges recent action by EPA in establishing a new ambient air-quality standard for particulate matter. The specific concern of Massachusetts was that EPA explicitly postponed imposing any controls on particulates that impair visibility and cause acid rain.

In an effort to influence Federal legislators, the leaders of nine major environmental organizations based in New England went to Washington, DC, in September to

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meet with members of the New England congressional delegations. Ten legislative issues were identified as environmental priorities for the 100th Congress. Among the issues identified were acid rain, offshore drilling, land protection, clean air regulation, and solid waste management.

In the advanced materials sector, Norton Co., Worcester, began a 2-year $800,000 contract with the U.S. Department of Energy's Oak Ridge Laboratory, Oak Ridge, TN, for the development of ceramic-to-ceramic joining of heat engine components. Ceramic components in engines, especially for aerospace applications, have advantages when compared with existing steel or superalloy parts in such critical areas as reduced weight and better heat, corrosion, and wear resistance. Norton will focus on silicon nitride and silicon carbide ceramics in the development effort. The program will concentrate on materials research, with actual component production slated for possible further contract extensions.

Under the ongoing State Mining and Mineral Resources Research Institute Program Act, the U.S. Bureau of Mines awarded an allotment grant of $138,000 to the Massachusetts Institute of Technology to support basic research in the mineral sciences. Under stipulations of the act, the State had to match the grant to the university on a 2-to-1 basis.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

In this section, nonfuel mineral commodities that were mined in Massachusetts in 1987 are discussed. Quantity and value data for these commodities are given in table 1.

Lime.—The value of lime production traditionally has ranked third or fourth of all the minerals mined in the State. Both quantity and value of lime sold in the State were withheld in 1987 because of their proprietary status. Two companies continued to manufacture lime in Berkshire County from locally quarried limestone. The lime was shipped within Massachusetts and to New York, Connecticut, and other States for use by the agricultural, chemical, and construction industries.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

In 1987, construction sand and gravel was the second leading mineral commodity produced in terms of value; this value accounted for more than 50% of the State's total mineral value. Nearly 120 companies mined construction sand and gravel in 13 counties. Main uses for the material were for concrete aggregate, road base and coverings, and fill.

During 1987, numerous hearings were held in at least three dozen towns concerning sand and gravel operations. Most of these hearings were the result of citizen concern about excessive noise, increased truck traffic, excessive dust, and contamination or disruption of the community's water wells. These hearings often resulted in new or stricter zoning laws being passed. Because of these new restrictive zoning laws, competition from other land developers, urban sprawl, and environmental regulations, many producers could not enter the market; others were forced to close, move elsewhere, or restrict their operations. This caused higher production costs, which were passed on to the consumers in the form of higher raw material costs. This is evident when the 1986 production and value of sand and gravel were compared with those of 1987. Even though production rose only 8% in 1987, value increased nearly 41% during the same period.

Industrial.—Industrial sand was mined by two companies in Middlesex and Plymouth Counties, primarily for use in molding and core and sandblasting.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone was the State's leading commodity produced, accounting for 45% of the State's total mineral value. The production of 14.9 million short tons represented the highest level of production in the State's history. Traprock (basalt) accounted for the majority of the stone produced, followed by granite and limestone. Major uses were for road construction and concrete aggregate.

The issuance of mining permits for crush-

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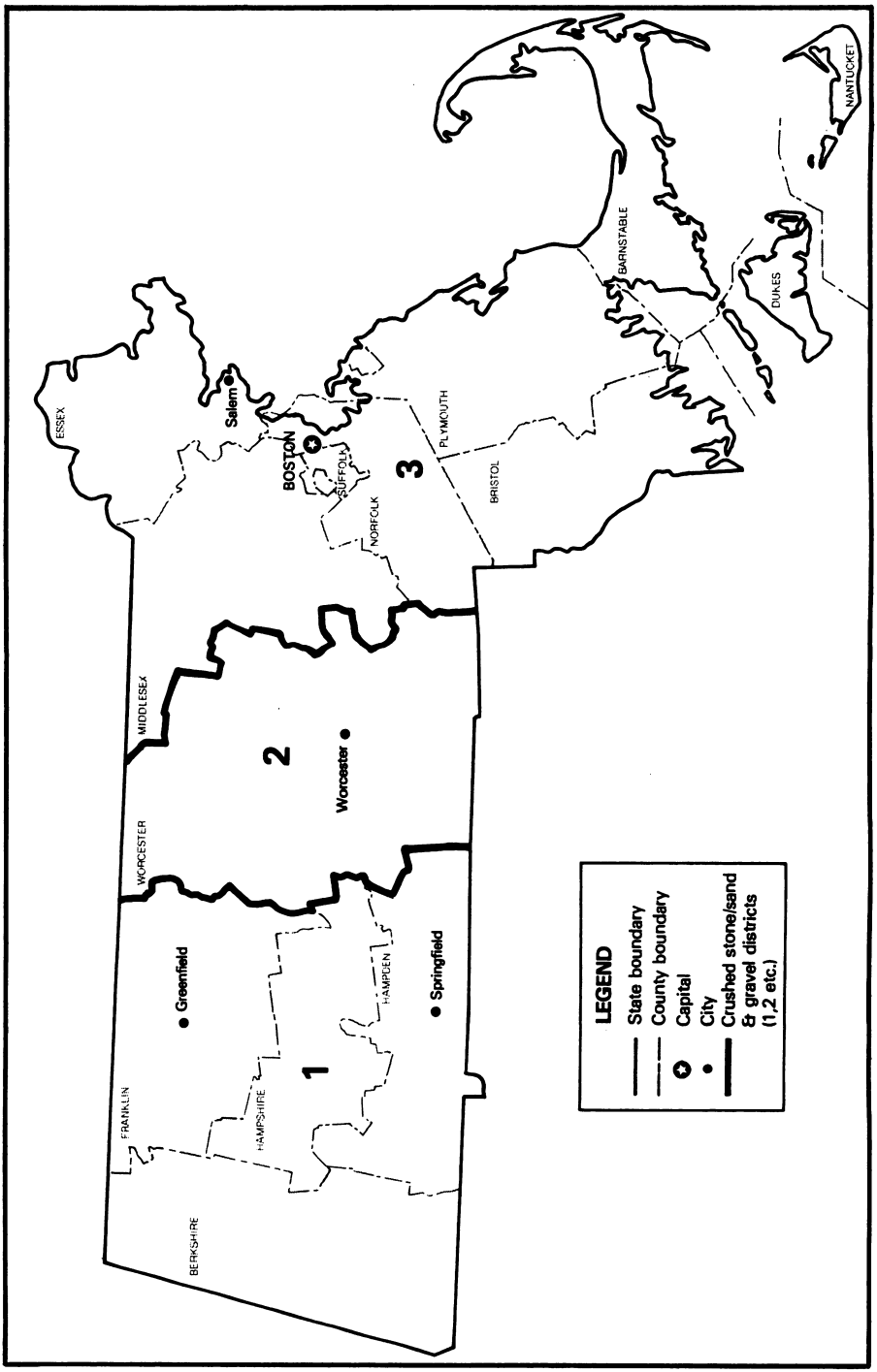

Figure 1.—Aggregate-producing districts in Massachusetts.

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ed stone, like sand and gravel, came under local control. As in the case of sand and gravel operations, stone operators came under attack primarily by citizens' groups complaining about noise, dust, blasting, and silt control. The results were that, despite historic production levels, some operators were forced to halt blasting and crushing operations and that others were denied permission to continue operations.

Table 3.—Massachusetts: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	71	484
Filter stone	42	294
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,175	7,494
Bituminous aggregate, coarse	939	6,739
Bituminous surface-treatment aggregate	372	3,702
Railroad ballast	27	212
Fine aggregate (-3/8 inch):		
Stone sand, concrete	211	1,365
Stone sand, bituminous mix or seal	473	2,326
Screening, undesignated	146	719
Coarse and fine aggregates:		
Graded road base and subbase	357	2,244
Terrazzo and exposed aggregate	21	W
Crusher run or fill or waste	799	5,267
Other construction[2]	714	4,849
Other miscellaneous[3]	739	4,113
Other unspecified[4]	8,820	39,159
Total[5]	14,907	78,969

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes granite, limestone, sandstone, traprock, and other miscellaneous stone.
[2]Includes madacam, coarse aggregate (graded), and unpaved road surfacing.
[3]Includes agricultural limestone and a minor amount in poultry grit and mineral food, lime manufacture, flux stone and asphalt fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

Table 4.—Massachusetts: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	W	W	W	W	52	352
Coarse aggregate, graded[2]	W	W	2,365	17,243		
Fine aggregate (-3/8)[3]	W	W	W	W	698	3,652
Coarse and fine aggregates[4]	W	W	W	W	1,019	6,452
Other construction	213	1,235	638	4,919	363	1,843
Agricultural[5]	(6)	(6)	--	--	--	--
Chemical and metallurgical[7]	(6)	(6)	--	--	--	--
Special[8]	3	(6)	--	--	--	--
Other miscellaneous	736	4,113	--	--	--	--
Other unspecified[9]	1,383	4,820	878	3,979	6,560	30,361
Total[10]	2,334	10,168	1,516	8,897	11,056	59,904

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregates, and railroad ballast.
[3]Includes stone sand (bituminous mix or seal) and fine aggregate (screening).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Includes agricultural limestone and poultry grit and mineral food.
[6]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[7]Includes lime manufacture and flux stone; included with "Other unspecified."
[8]Includes asphalt filler.
[9]Includes production reported with a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

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Dimension.—Massachusetts ranked fourth nationally in dimension stone output, up from fifth in 1986. Dimension granite was quarried in Berkshire, Middlesex, and Plymouth Counties primarily for curbing. A small amount of dimension marble was also quarried and sold as rough blocks.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three Massachusetts districts depicted in figure 1.

Other Industrial Minerals.—Two companies continued to produce common clay from two operations in Plymouth County. The clay was used primarily for the manufacture of face brick. Reed-sedge peat was produced by one company in Worcester County for agricultural purposes.

In addition to the commodities listed in table 1, the production and value of some processed or manufactured mineral commodities were also surveyed by the U.S. Bureau of Mines. Norton Co., the world's leading manufacturer of abrasives, produced bonded and coated abrasives at its plant in Worcester. During the year, the company announced that it would move its alumina-zirconia manufacturing facilities from Worcester to a newly expanded $6 million plant in Niagara Falls, Ontario, Canada. Washington Mills Abrasive Co., North Grafton, processed emery from a mine in New York for use as a nonslip additive for floors, pavements, and stair treads; and Dresser Industries Inc., General Abrasive Div., Westfield, produced aluminum oxide and silicon carbide abrasives for the grinding wheel, coated abrasive, refractory, and metallurgical industries. Two companies, both in Lowell, Middlesex County, produced high-modulus graphite fiber used primarily by the aerospace industry. Raw mineral products were also imported into the State for further processing. Crude gypsum shipped into the State from company-owned mines in other States and Canada was calcined by USG Corp. near Boston and made into wallboard for the New England market. Crude perlite, mined in New Mexico, was expanded by Whittemore Products Inc. at a plant in Essex County. The expanded perlite was used in lightweight aggregate and as a horticultural medium. W. R. Grace & Co. exfoliated vermiculite at its Easthampton plant in Hampshire County for use in insulation and fireproofing.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]State geologist, Executive Office of Environmental Affairs, Boston, MA.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
K-F Brick Co. Inc	River St. Middleboro, MA 02346	Pit	Plymouth.
Stiles & Hart Brick Co	Box 367 Bridgewater, MA 02324	Pit	Do.
Graphite (synthetic):			
Avco Corp	1275 King St., Box 9000 Greenwich, CT 06836	Plant	Middlesex.
The Stackpole Corp	Foundry Industrial Park Lowell, MA 01852	do	Do.
Gypsum (calcined):			
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Suffolk.
Lime:			
Lee Lime Corp.[1]	Marble St. Lee, MA 01238	Plant and quarry.	Berkshire.
Pfizer Inc.[1]	260 Columbia St. Adams, MA 01220	do	Do.
Peat:			
Sterling Peat Co	Sterling Junction, MA 01565	Bog	Worcester.
Perlite (expanded):			
Whittemore Products Inc	Dundee Park Andover, MA 01810	Plant	Essex.

See footnote at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
E. L. Dauphinais Inc	160 Worcester St., Box 488 North Grafton, MA 01536	Pits	Worcester.
Kimball Sand Co. Inc	Providence Rd., Box 29 Mendon, MA 01756	do	Do.
S. M. Lorusso & Sons Inc	331 West St. Walpole, MA 02081	do	Norfolk.
Rosenfeld Concrete Corp	Drawer E Milford, MA 01757	do	Worcester.
San-Vel Concrete Corp	Ayer Rd. Littleton, MA 01460	Pit	Middlesex.
Industrial:			
Holliston Sand Co. Inc	303 Lowland St., Box 97 Holliston, MA 01746	Pit	Do.
Whitehead Bros. Co	Box 259, River Rd. Leesburg, NJ 08327	Pit	Plymouth.
Stone:			
Crushed:			
John S. Lane & Son Inc	730 East Mountain Rd. Westfield, MA 01085	Quarries	Berkshire, Hampden, Hampshire.
S. M. Lorusso & Sons Inc	331 West St. Walpole, MA 02081	do	Middlesex, Norfolk, Suffolk.
Simeone Corp	1185 Turnpike St. Stoughton, MA 02072	do	Bristol and Norfolk.
Tilcon Inc	Box 114 72 South Main St. Acushnet, MA 02743	Quarry	Bristol.
Trimount Bituminous Products Co.	1935 Revere Beach Parkway Everett, MA 02149	Quarries	Essex.
Dimension:			
Fletcher Granite Co	West Chelmsford, MA 01863	Quarry	Middlesex.
Williams Stone Co. Inc	Box 278 East Otis, MA 01029	do	Berkshire.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Hampshire.

[1]Also stone

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The Mineral Industry of Michigan

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey Division, Michigan Department of Natural Resources, for collecting information on all nonfuel minerals.

By James J. Hill[1]

Michigan's nonfuel mineral production was valued at nearly $1.4 billion in 1987, surpassing the 1986 value by over 10%. The State ranked fifth nationally in mineral production value and contributed 5% to the U.S. total. Michigan was the Nation's leading producer of calcium compounds, crude gypsum, iron oxide pigments, and magnesium compounds. It ranked second in production of bromine, iron ore, peat, and industrial sand, and third in output of construction sand and gravel. Increased output of iron ore, followed by salt, crushed stone, and copper, accounted for most of the State's value increase. Metallic minerals (copper, gold, iron ore, and silver) made up

Table 1.—Nonfuel mineral production in Michigan[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	W	W	257	$17,026	263	$23,004
Portland do.	W	W	4,713	216,120	4,755	207,332
Clays do.	1,477	$5,514	1,402	5,684	1,333	5,338
Gem stones	NA	e15	NA	25	NA	25
Gypsum thousand short tons	1,772	11,883	1,979	11,052	1,977	12,190
Iron ore (usable) thousand long tons, gross weight	12,629	W	10,957	W	12,312	W
Lime thousand short tons	535	24,790	556	27,257	569	30,320
Peat do.	282	5,414	r324	r6,599	281	5,290
Salt do.	927	71,224	W	W	W	W
Sand and gravel:						
Construction do.	e38,000	e93,000	42,514	91,886	e42,800	e105,300
Industrial do.	3,345	25,469	3,343	29,493	2,792	22,451
Stone:						
Crushed do.	30,685	95,953	e27,800	e83,900	37,909	109,514
Dimension do.	4	113	e6	e148	W	W
Combined value of bromine, calcium chloride (natural), copper, gold, iodine (1985), iron oxide pigments (crude), magnesium compounds, silver, and values indicated by symbol W	XX	1,053,672	XX	r750,393	XX	844,846
Total	XX	1,387,047	XX	r1,239,583	XX	1,365,610

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Michigan in 1986, by county[1]

County	Minerals produced in order of value
Alger	Sand and gravel (construction).
Allegan	Sand and gravel (construction), peat.
Alpena	Cement, clays, sand and gravel (construction).
Antrim	Sand and gravel (construction).
Arenac	Do.
Baraga	Do.
Barry	Do.
Bay	Cement, lime.
Benzie	Sand and gravel (construction).
Berrien	Sand (industrial), sand and gravel (construction).
Branch	Sand and gravel (construction).
Calhoun	Do.
Cass	Do.
Charlevoix	Cement, sand and gravel (construction).
Cheboygan	Sand and gravel (construction).
Chippewa	Do.
Clare	Do.
Clinton	Sand and gravel (construction), peat.
Crawford	Sand and gravel (construction).
Delta	Do.
Dickinson	Do.
Eaton	Sand and gravel (construction), peat.
Emmet	Sand and gravel (construction).
Gogebic	Do.
Grand Traverse	Do.
Gratiot	Do.
Hillsdale	Do.
Houghton	Do.
Huron	Sand and gravel (construction), lime.
Ingham	Sand and gravel (construction), peat.
Ionia	Sand and gravel (construction).
Iosco	Gypsum, sand and gravel (construction).
Iron	Sand and gravel (construction).
Isabella	Do.
Jackson	Do.
Kalamazoo	Do.
Kent	Sand and gravel (construction), gypsum.
Lake	Sand and gravel (construction).
Lapeer	Sand and gravel (construction), calcium chloride, peat.
Leelanau	Sand and gravel (construction).
Lenawee	Do.
Livingston	Do.
Luce	Do.
Mackinac	Sand and gravel (construction), sand (industrial).
Macomb	Sand and gravel (construction).
Manistee	Magnesium compounds, salt, bromine, sand and gravel (construction).
Marquette	Iron ore, gold, sand and gravel (construction), iron oxide pigments, silver.
Mason	Calcium chloride, magnesium compounds, lime, bromine, sand (industrial).
Mecosta	Peat, sand and gravel (construction).
Menominee	Sand and gravel (construction).
Midland	Calcium chloride, magnesium compounds, bromine.
Missaukee	Sand and gravel (construction).
Monroe	Cement, clays, peat.
Montcalm	Sand and gravel (construction).
Muskegon	Sand (industrial), sand and gravel (construction).
Newaygo	Sand and gravel (construction).
Oakland	Sand and gravel (construction), peat.
Oceana	Sand (industrial), sand and gravel (construction).
Ogemaw	Sand and gravel (construction).
Ontonagon	Copper, silver, sand and gravel (construction).
Osceola	Sand and gravel (construction).
Oscoda	Do.
Otsego	Do.
Ottawa	Sand and gravel (construction), sand (industrial).
Presque Isle	Sand and gravel (construction).
Roscommon	Do.
Saginaw	Lime, sand and gravel (construction).
St. Clair	Salt, sand and gravel (construction).
St. Joseph	Peat, sand and gravel (construction).
Sanilac	Peat, sand and gravel (construction), lime.
Schoolcraft	Sand and gravel (construction).
Shiawassee	Peat, clays, sand and gravel (construction).
Tuscola	Sand and gravel (construction), sand (industrial), lime.
Van Buren	Sand (industrial), sand and gravel (construction).
Washtenaw	Sand and gravel (construction).
Wayne	Cement, lime, sand (industrial), sand and gravel (construction), clays.
Wexford	Sand (industrial), sand and gravel (construction).
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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41% of the State's mineral value. Cement was the leading industrial mineral commodity in terms of value, followed by crushed stone, construction sand and gravel, magnesium compounds, salt, and calcium chloride. Output declined for calcium chloride, clays, gold, gypsum, peat, and industrial sand. Production increased for all other mineral commodities mined in the State except bromine, which remained at about the same level as in 1986.

Employment.—The Michigan Employment Security Commission reported the State's unemployment rate as 8.2% in 1987, down from 8.8% in 1986. In the Upper Peninsula, unemployment was at 10.6%, nearly 21% below the 13.4% rate reported in 1986. Statewide, employment in mining reached 9,800 persons, a 2% increase over that of 1986. Mining employment in the Upper Peninsula was 3,400 persons, about 6% more than the 3,200 persons reported in 1986. No strikes were reported in the State's mining industry in 1987.

Exploration Activities.—In May, the State held its fifth metallic minerals lease sale offering more than 7,600 acres in Iron, Marquette, and Menominee Counties. Eight bidders were registered in the sale, and four bidders were successful in placing high bids on a total of 2,608.34 acres. Bonus paid was $28,613.60, an average of $10.96 per acre. Bids ranged from $1.27 to $20.10 per acre, with the highest bid received for a 40-acre tract in Mansfield Township, Iron County. Iron County received the greatest attention in the sale with 1,295.80 acres leased. A summary of the sale follows:

Successful bidder	Acres	Bonus bid
Callahan Mining Corp	880.00	$9,876.80
Exmin Corp	1,302.30	12,890.10
Kerr-McGee Corp	160.00	4,008.00
Jack Murphy	266.04	1,838.70
Total	2,608.34	28,613.60

Source: Michigan Natural Resouces Commission.

At yearend, Michigan had 20,837 acres of State-owned mineral land under lease for metallic minerals. Total income from leasing realized by the State since 1982 was more than $1.4 million.

On January 26, 1987, administrative rules governing nonmetallic minerals became effective. No public sales of nonmetallic mineral leases were held during 1987, although one company received a direct lease for sand and gravel resources.

Drilling was conducted by 10 entities in the Upper Peninsula during 1987 with most of the activity focused on base and precious metals and diamonds. One hundred and forty-two holes were drilled for a total of 76,008 feet. Amoco Oil Co. spudded a stratigraphic test southeast of Munising, near Wetmore, that was permitted to 6,000 feet. Results of this test were held confidential.

Shipping.—The 1987 commercial navigation season through the U.S. locks at Sault Ste. Marie began on March 22 and ended 300 days later on January 15, 1988. The U.S. Army Corps of Engineers reported that 5,104 cargo carriers passed through the lock in the 1987 season, an increase of 892 from 1986. Total tonnage passing through the locks was 85.8 million short tons, a 23% increase when compared with the 69.6 million tons passing through in 1986. The following table summarizes the mineral commodity traffic passing through the locks in 1986 and 1987.

Table 3.—Michigan: Mineral products shipped through the Sault Ste. Marie locks

(Short tons)

Commodity	1986	1987
Cement	469,428	296,237
Coal	13,824,535	15,880,174
Iron ore	32,782,521	43,267,148
Iron and steel (manufactured), pig iron	317,995	499,091
Potash	1,573,846	1,676,495
Salt	261,265	308,046
Scrap (ferrous)	42,175	19,472
Stone[1]	1,631,101	2,909,199
Total	50,902,866	64,855,862

[1]Includes broken stone, gravel, and sand.

Source: U.S. Army Corps of Engineers, Detroit District.

The Lake Carriers' Association reported 55.1 million long tons of iron ore moved on the Great Lakes in 1987, a 21% increase over the 45.6 million tons moved in 1986. Of this, 12,969,710 tons originated at the Michigan ports of Escanaba and Marquette, compared with 10,951,963 tons in 1986.

Legislation and Government Programs.—Two bills specific to mining were enacted into law during 1987. Public Act 24 waived the single business tax for iron ore producers for 5 years. This action reduced Cleveland-Cliffs Iron Co.'s (CCIC) costs by about $1.50 per long ton, allowing it to remain competitive with other iron ore producers. Public Act 94 amended the Sand Dune Protection and Management Act and provided that unexpended surveillance fees in one fiscal year be credited and deducted

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from the amount appropriated in the succeeding year for surveillance, monitoring, administration, and enforcement of the Sand Dune Act. Mine operators are assessed as much as 10 cents per short ton of material mined for these purposes.

On the Federal level, the Michigan Wilderness Act of 1987, Public Law 100-184, was signed by the President on December 8, ending a 7-year battle in Congress on whether or not certain areas in Michigan should be designated wilderness. The law bans economic activities on 92,000 acres, which includes six tracts in the Hiawatha National Forest, three tracts in the Ottawa National Forest, and one tract in the Huron-Manistee National Forest.

The Michigan Geological Survey Division, established by statute when the State was only 2 hours old, celebrated its 150th anniversary with an open house in November. For the past several years, a systematic evaluation program has been under way in cooperation with the Department of Geology & Geological Engineering at Michigan Tech in Houghton to provide a geologic data base to promote mineral exploration in Michigan. Several open file reports were published by the survey in 1987 as part of this program. Eventually, individual project areas will be integrated to provide a regional geological framework for precious metals exploration.

Michigan Tech broke ground for its new Minerals and Materials Engineering building on July 17. The structure will house academic and research programs in metallurgy, materials processing, and mining, as well as the Institute of Materials Processing. Cost of construction, equipment, and furnishings was estimated at $47.7 million. The Mining and Mineral Resources Research Institute at Michigan Tech received $266,384 from the U.S. Bureau of Mines under Public Law 98-409, which makes funds available to research institutions to assist in the training of engineers and scientists in mineral-related disciplines.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Bromine.—Michigan and Arkansas were the only two States producing bromine in 1987. Production from well brines continued at The Dow Chemical Co.'s Ludington plant, Mason County. Production and attendant value were estimated to have remained essentially the same as in 1986. Dow Chemical sold the majority of its worldwide bromine chemical business assets to Ethyl Corp. of Baton Rouge, LA, in May.

Calcium Chloride.—Michigan remained the number one producer of calcium compounds, far outranking California and Washington in production. Calcium chloride was recovered from well brines by Dow Chemical at its Ludington plant, Mason County, and Wilkinson Chemical Corp. at its Mayville plant, Lapeer County. Dow Chemical's plant produced calcium chloride pellets and flake. Wilkinson marketed calcium chloride solutions only. Production and value were estimated to have declined 4% and 20%, respectively.

Cement.—Nationally, Michigan ranked fifth and sixth, respectively, in sales of portland and masonry cement. Sales increased slightly for both kinds of cement. Average value of portland cement was $43.60 per short ton, down $2.26 from the 1986 figure. The Michigan average value was 10% below the national average of $48.71 per ton. Masonry cement sales averaged $87.45 per ton, a 32% increase over the 1986 figure of $66.16. Nationally, sales of masonry cement averaged $70.63 per ton. Five companies produced cement at four manufacturing plants (two dry and two wet process) and one grinding facility. All of Michigan's 13 kilns were active at some time during the year. Masonry cement sales were reported by all companies as were sales of Types I and II, general-use and moderate-heat portland cement. One or more companies reported sales of Type III, high-early-strength, pozzolan, white, and waterproof portland cements. Approximately 95% of portland cement sales were to ready-mixed concrete companies, concrete product manufacturers, and highway contractors. All shipments to consumers were by truck; 99% was shipped in bulk form.

Approximately 8.0 million tons of material was consumed in cement manufacture. This included 5.7 million tons of limestone, 1.3 million tons of clay, and lesser quantities of anhydrite, clinker, fly ash, gypsum, iron ore, and sand.

Cement shipments to and within Michigan during 1987 included 2,740,000 tons of portland cement and 146,000 tons of masonry cement. Compared with 1986 data, this represented 262,000 tons more of portland

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cement and 19,000 tons more of masonry cement.

Lafarge Corp. reopened its Alpena plant in March after having purchased it from National Gypsum Co. at yearend 1986. The firm restructured its operations and formed a new Great Lakes Region that combined the assets of the former Huron Cement Div. of National Gypsum, General Portland Inc.'s Peninsular Div., and Canada Cement, Lafarge's Ontario Region. Through a network of 22 distribution centers, the new organization served customers in Ontario and in all or parts of the Great Lakes States, which included Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin.

Medusa Cement Corp. began modifying the finish grinding circuits at its Charlevoix plant during the year. Major equipment to be installed included three high-efficiency separators, three dust collectors, and associated pneumatic conveying equipment.

Clays.—Production of common clay and shale declined about 5%, and value of sales was down about 6%. Average value per short ton dropped 5 cents. Five companies with operations in four counties reported production. Alpena County was the leading producer. Most of Michigan's clay output was used in cement manufacture. Lesser quantities were used for making brick and flowerpots. Local potters also used small quantities of Michigan clay in their art studios.

Gypsum.—Michigan ranked first of 21 States in crude gypsum production. Output declined slightly in 1987, but value increased about 10%. Michigan's crude gypsum was valued at $6.17 per short ton in 1987, up from $5.58 per ton in 1986. Nationally, crude gypsum was valued at $6.85 per ton. Five companies with mines in Iosco and Kent Counties reported production. All companies but one operated calcining plants. Output of calcined product increased nearly 9%; value by almost 5%. Most of the State's gypsum was used in wallboard manufacture, lesser quantities were used for soil conditioning, building plaster, and cement manufacture.

USG Corp.'s Alabaster Mine and National Gypsum's Tawas Mine, both in Iosco County, ranked second and fourth, respectively, in production nationally.

Lime.—Nationally, Michigan ranked 10th of 34 States in lime output. Production increased about 2% and value about 11%. Lime was manufactured by five companies at eight plants in seven counties. All companies produced quicklime; one company also produced hydrated lime. Wayne County accounted for most of the State's production and value. Michigan Sugar Co. operated the greatest number of plants. Lime was used in steelmaking, sugar refining, and water treatment.

Magnesium Compounds.—Michigan ranked first of five States in the production of magnesium compounds. In terms of value, magnesium compounds ranked fifth in contributing to the State's total nonfuel mineral economy. Production and sales were estimated to have increased by 12% and 2%, respectively, when compared with those of 1986. Improvements in the steel industry created increased demand for magnesium refractory products. Three companies had operations in Manistee, Mason, and Midland Counties. Products consisted of magnesium carbonate, magnesium hydroxide, magnesium sulfate, caustic-calcined magnesia, and refractory magnesia.

Peat.—Michigan was outranked only by Florida among the 22 States reporting peat sales in 1987. Sales dropped by 13%, and value fell by nearly 20% when compared with 1986 figures. Average value per short ton dropped from $20.37 in 1986 to $18.82 in 1987. Thirteen companies harvested peat from 15 operations in 10 counties. Sanilac County led the State in production and sales. Reed-sedge peat accounted for 70% of the peat sold. More than 99% of sales were for general soil improvement. About 73% of sales were in packaged form.

Salt.—Nationally, Michigan ranked ninth of 15 States in sales of salt. Sales and value increased 21% and 49%, respectively. Salt was solution mined by two companies: Diamond Crystal Salt Co. had operations in Manistee and St. Clair Counties, and Morton Thiokol Inc. had an operation in Manistee County. Both companies evaporated salt with vacuum pans; Diamond Crystal also operated open pans at its St. Clair facility. Major sales of salt were for food and chemical processing and as table salt. Salt was sold in bulk, as pressed blocks, and in packaged form.

In early April, Diamond Crystal announced that it had retained an investment banking firm to seek a buyer for its salt division because of the lack of capital needed to remain competitive. In July, a purchase agreement was signed with Akzo Chemical American, parent company of In-

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ternational Salt Co., for International Salt to purchase Diamond Crystal for $65 million. The sale, which was expected to be completed in early 1988, included Diamond Crystal's plants in St. Clair and Manistee, MI; Akron, OH; and Williston, ND; and a solar salt plant at Great Salt Lake, UT.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the fourth leading mineral commodity produced in the State in terms of value. Nationally, the State ranked third in sales, following California and Texas. Output in 1987 was estimated at 42.8 million short tons, a slight increase over the production reported for 1986. Attendant value was estimated at $105.3 million, an increase of nearly 15% over that of 1986. Housing and nonresidential construction remained strong in 1987, although not quite as high a level as in 1986, continuing the demand for sand and gravel products. State road contract awards jumped 35% in value, which also helped sand and gravel sales.

Michigan's second largest sand and gravel producer, American Aggregates Corp., was purchased early in the year by ARC America Corp. of Newport Beach, CA, a subsidiary of Consolidated Gold Fields PLC of the United Kingdom. American Aggregates had five operations in Kalamazoo, Livingston, Macomb, and Oakland Counties.

Industrial.—Michigan ranked second nationally in industrial sand output, trailing Illinois, the number one producer. Production and value dropped 16% and 24%, respectively, when compared with 1986 figures. Sand was mined by 9 companies from 19 pits in 12 counties. Ottawa County led the State in production, followed by Van Buren and Muskegon Counties. Approximately 84% of the sand was used by foundries for molding and core. The remainder was used for chemicals, engine traction, fiberglass, fillers, glass manufacture, refractories, sand blasting, and other miscellaneous uses. About 42% of the sand was shipped to consumers by truck.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone sales totaled 37.9 million short tons valued at $109.5 million in 1987, a 36% and a 31% increase, respectively, over figures estimated for 1986. Some of this increase may have been due to underestimation of 1986 production. Another reason is increased sales of limestone for fluxed pellet production at Michigan and Minnesota taconite operations, as well as increased demand by the revitalized steel industry. Crushed stone was produced by 28 companies at 33 quarries in 21 counties. Limestone and dolomite from 28 quarries constituted the major part of the output; marl was produced from 3 quarries, and quartzite and traprock from 1 quarry each. Presque Isle County was the State's leading producer, followed by Mackinac, Monroe, Schoolcraft, and Alpena Counties.

Table 5 presents end-use data for crushed stone produced in the three Michigan districts depicted in figure 1.

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Table 4.—Michigan: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	246	1,198
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,643	4,538
Bituminous aggregate, coarse	571	1,458
Railroad ballast	21	60
Fine aggregate (-3/8 inch)	115	546
Coarse and fine aggregates:		
Graded road base or subbase	1,765	4,968
Unpaved road sufacing	2,408	7,548
Crusher run or fill or waste	56	274
Other construction[2]	249	479
Agricultural:		
Agricultural limestone	197	1,032
Other agricultural	20	67
Chemical and metallugical:		
Cement manufacture	5,386	9,053
Flux stone	2,982	10,820
Special: Other miscellaneous[3]	3,543	11,474
Other unspecified[4]	18,705	56,005
Total[5]	37,909	109,514

[1]Includes limestone, dolomite, quartzite, marl, and traprock.
[2]Includes macadam, filter stone, bituminous surface-treatment aggregate, and stone sand (concrete and bituminous mix or seal).
[3]Includes poultry grit and mineral food and lime manufacture.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

Table 5.—Michigan: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	65	391	260	640	99	458
Coarse aggregate, graded[2]	W	W	1,211	2,697	W	W
Fine aggregate (-3/8 inch)[3]	W	W	17	35	W	W
Coarse and fine aggregates[4]	122	460	1,969	3,643	2,138	8,682
Other construction	784	2,174	(5)	1	412	1,884
Agricultural[6]	25	(7)	--	--	207	(7)
Chemical and metallurgical[8]	(7)	(7)	8,299	18,260	(7)	(7)
Other unspecified[9]	10,146	32,061	8,248	21,428	3,908	16,701
Total[10]	11,142	35,086	20,008	46,704	6,765	27,724

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screenings).
[4]Include graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Less than 1/2 unit.
[6]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[7]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[8]Includes cement manufacture, lime manufacture, and flux stone.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

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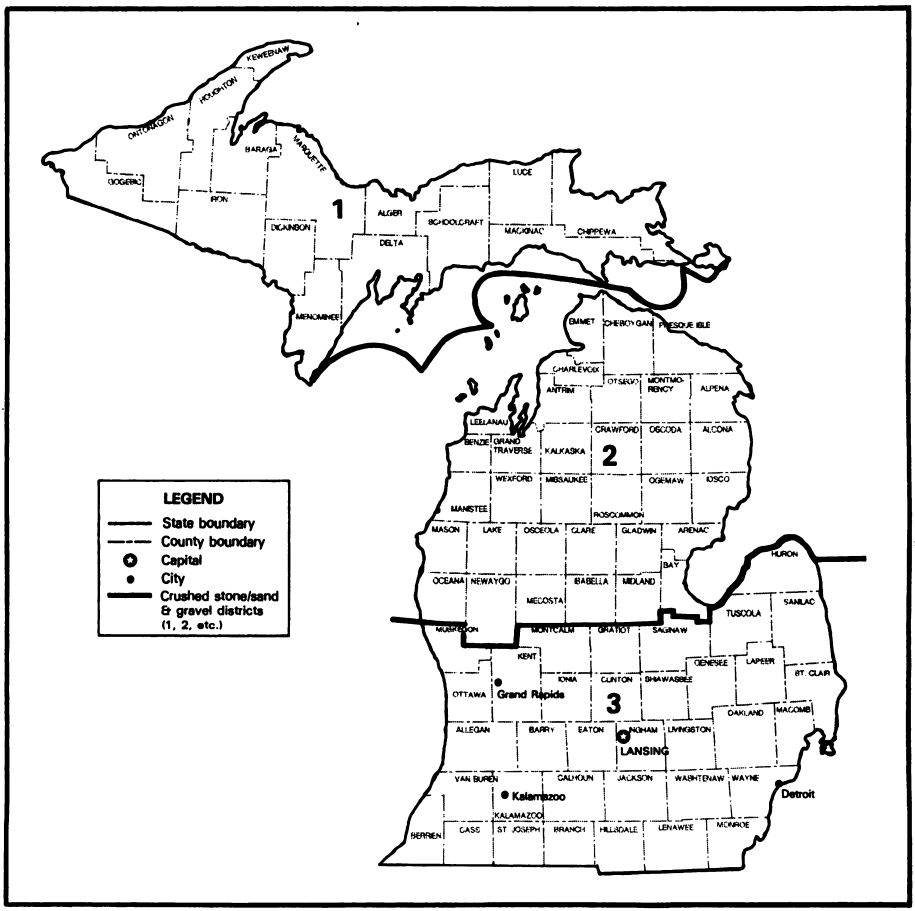

Figure 1.—Aggregate-producing districts in Michigan.

In September, USX Corp. sold its Michigan limestone quarries to Michigan Limestone Operations Ltd. Partnership, a company formed by former USX executives. The sale included a long-term agreement for the partnership to supply the limestone requirements of USS, the steelmaking arm of USX.

Dimension.—Sandstone for use as curbing was produced by Jude Stone Quarry Co. near Napoleon in Jackson County. Dolomite was quarried and dressed by Inwood Stone Products Co. in Schoolcraft County for use as flagging, veneer, and other miscellaneous uses. Production and value increased modestly in 1987.

Other Industrial Minerals.—Production of gem stones and mineral specimens was valued at $25,000 in 1987. Crude perlite from out-of-State sources was expanded by two companies with operations in Kalamazoo and Wayne Counties. Production and attendant value increased 3% and 4%, respectively. Sales of processed iron and steel slag from Michigan's steel mills declined 21% in 1987. Large quantities of the processed slag were for road base material and concrete aggregate. Elemental sulfur was recovered at two refineries. Sales and value declined 6% and 12%, respectively. Out-of-State vermiculite was exfoliated by one company. Sales increased about 5%. Aver-

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age value per short ton dropped about 13%. The largest percentage of sales was for fireproofing and block insulation.

METALS

Copper, Gold, and Silver.—Nationally, Michigan ranked 5th, 8th, and 11th, respectively, in the production of copper, silver, and gold. Output was from two mines: copper-silver from Copper Range Co.'s White Pine Mine in Ontonagon County and gold-silver from Callahan Mining Corp.'s Ropes Mine in Marquette County. Production of copper and silver increased 17% and 16%, respectively, in 1987. Gold production was down about 10%. Copper prices averaged 82 cents per pound in 1987 compared with 66 cents per pound in 1986. Gold prices averaged $447.95 per troy ounce, up from $368.24 per troy ounce in 1986. Silver prices increased from $5.47 per troy ounce in 1986 to $7.01 per troy ounce in 1987.

The reopened White Pine Mine completed its second year of production in 1987 and employed about 930 persons at yearend. Employees received their first payout under the employee stock ownership plan. An average of 175 shares per worker was distributed, with each share valued at $24.40. Employees also received about $1 million in incentive pay at the rate of 50 cents for each hour worked since January 1, 1986.

The Ropes Mine completed its second year of production in 1987. Problems were encountered during the year with a fall-off in ore grade caused by excess dilution and mechanical problems in the mill. On the last day of the year, a surface subsidence at the mine forced a shutdown that was expected to last several months.

Iron Ore.—Iron ore was Michigan's leading commodity in terms of value. The State continued to rank second, behind Minnesota, in shipments of iron ore. All production was in the form of pellets from the Empire and Tilden Mines, partially owned and managed by CCIC. During the year, CCIC successfully converted both the Empire and Tilden facilities to fluxed pellet production, which lowers steelmaking costs. CCIC's wholly owned Republic Mine remained shut down throughout the year. Taconite shipments climbed to 12.3 million long tons in 1987 from 11.0 million tons in 1986. Of these, 3.5 million tons were fluxed pellets. Value of the ore shipments increased about 11%.

Table 6.—Michigan: Usable iron ore[1] produced (direct shipping and all forms of concentrates), by range

(Thousand long tons, gross weight, unless otherwise specified)

Year	Marquette Range	Menominee Range (Michigan part)	Gogebic Range (Michigan part)	Total		
				Gross weight		
				Ore	Iron content	Iron content (percent)
1854-1982	529,988	[2]316,232	[3]249,625	1,095,845	NA	NA
1983	9,339	--	--	9,339	6,024	64.5
1984	12,982	--	--	12,982	8,374	64.5
1985	12,479	--	--	12,479	8,052	64.5
1986	10,558	--	--	10,558	6,802	64.4
1987	12,294	--	--	12,294	7,830	63.7
Total	587,640	[4]316,232	[4]249,625	1,153,497	NA	NA

NA Not available.
[1]Exclusive after 1905 of iron ore containing 5% or more manganese.
[2]No production after 1981.
[3]No production after 1979.
[4]Distribution by range partly estimated before 1906.

Crude iron oxide pigments continued to be shipped from stockpile at CCIC's Mather Mine in Marquette County.

Cleveland-Cliffs Inc. reorganized early in the year and formed a new subsidiary, Cliffs Mining Co., to manage its iron ore and coal business after its acquisition of Pickands Mather & Co. in late 1986. Cliffs Mining now owns CCIC and Pickands Mather, which together manage and operate eight iron ore pellet plants in the United States, Canada, and Australia, along with five active metallurgical and steam coal mines in the United States.

In late April, CCIC officials unveiled a plan to begin mining a magnetite deposit north of the Tilden pit that would allow for production of higher quality iron ore pellets

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at lower costs. In December, CCIC steelworkers ratified a new 3-year contract that provided for wage deferrals to help finance the magnetite project. At yearend, CCIC was waiting for approval of its steel company partners to go ahead with the project.

On December 31, Cleveland-Cliffs Inc. completed the sale of its coal-fired power plant at Marquette to Wisconsin Electric Power Co. as part of its restructuring effort. The sale resulted in significantly lowering energy costs for the Empire and Tilden operations under new long-term power contracts.

Iron and Steel.—The American Iron and Steel Institute reported Michigan ranked fourth in raw steel production with output climbing to 7.1 million short tons in 1987. Pig iron production remained about the same as in 1986.

Michigan's steel industry continued its restructuring and cost-cutting efforts and investment in new technology.

McLouth Steel Products Co. came close to closure during 1987 with debts exceeding $100 million. In August, a new 3-year contract was reached with the United Steelworkers of America Union that represented McLouth's 1,900 workers. The contract provided for a 10% wage reduction and other benefit cuts in exchange for the employees receiving 85% ownership in the company under a new reorganization plan. Negotiations with creditors and other interested parties continued to yearend.

National Steel Corp. put a new $245 million continuous caster and ladle metallurgy station on-stream at its Ecorse plant in late 1987. The facilities are capable of producing 2.2 million short tons of high-quality steel slabs annually.

Rouge Steel Co. announced in March that it was closing the 116 coke ovens at its Dearborn complex because of high costs. Coke was to be purchased from outside suppliers. In July, Rouge's 3,800 hourly workers approved a new 3-year contract that continued a wage freeze and allowed some work rule changes. In turn, Rouge was to upgrade the steel complex. Construction on a $100 million upgrade of the plant began in October. One of the complex's three blast furnaces was to be relined, computerized controls were to be installed at the hot-strip mill, and the cold mill facilities were to be modernized. Also, the plant's coal-fired powerhouse was to be converted to natural gas.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Aetna Cement Corp., a subsidiary of Société des Ciments Française	Box 80 Essexville, MI 48732	Grinding plant	Bay.
Dundee Cement Co., a division of Holderbank Financiere Glaris SA.[1 2]	Box 122 Dundee, MI 48131	Quarry, clay pit, plant	Monroe.
Lafarge Corp., Great Lakes Region[2]	4000 Town Center Suite 2000 Southfield, MI 48075	do	Alpena.
Medusa Cement Co., Medusa Corp., a subsidiary of Crane Co.[1 2]	Box 5668 Cleveland, OH 44101	do	Charlevoix.
St. Marys Peerless Cement Co., a division of St. Marys Cement Ltd.	9333 Dearborn St. Detroit, MI 48209	Plant	Wayne.
Clays:			
F. W. Ritter Sons Co	12670 North Dixie Hwy. South Rockwood, MI 48179	Clay pit and plant	Monroe.
Charles J. Rogers Inc	Box 3080 Melvindale, MI 48122	Clay pit	Wayne.
U.S. Brick Inc., Michigan Div., a subsidiary of Canada Brick Co.	3820 Serr Rd. Corunna, MI 48817	Clay pit and plant	Shiawassee.
Copper:			
Copper Range Co.[3]	Box 100 White Pine, MI 49971	Underground mine, concentrator, smelter, refinery.	Ontonagon.
Gold:			
Callahan Mining Corp.[3]	6245 North 24th St. Phoenix, AZ 85016	Underground mine and plant.	Marquette.
Gypsum:			
Domtar Industries Inc	Box 1670 Grand Rapids, MI 49501	do	Kent.
Georgia-Pacific Corp	133 Peachtree St., NE. Atlanta, GA 30303	do	Do.
Michigan Gypsum Co	2840 Bay Rd. Saginaw, MI 48603	Open pit mine	Iosco.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	Open pit mine and plant.	Do.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	Open pit mine Plant	Do. Wayne.

See footnotes at end of table.

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Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iron ore:			
Cleveland-Cliffs Iron Co.[4]	504 Spruce St. Ishpeming, MI 49849	Open pit mines and plants.	Marquette.
Iron and steel:			
McLouth Steel Products Corp	1650 West Jefferson Trenton, MI 48183	Plant	Wayne.
National Steel Corp., Great Lakes Steel Div.	1 Quality Dr. Ecorse, MI 48229	do	Do.
Rouge Steel Co., a subsidiary of Ford Motor Co.	3001 Miller Rd. Dearborn, MI 48121	do	Do.
Lime:			
Dotroit Lime Co., a subsidiary of Edward C. Levy Co.	8800 Dix Hwy. Dearborn, MI 48823	do	Do.
The Dow Chemical Co., Ludington Div	2020 Dow Center Midland, MI 48640	do	Mason.
Marblehead Lime Co., a division of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	Plants	Wayne.
Michigan Sugar Co	Box 1348 Saginaw, MI 48605	do	Huron, Saginaw, Sanilac, Tuscola.
Monitor Sugar Co	2600 South Euclid St. Bay City, MI 48706	Plant	Bay.
Peat:			
Al-Par Peat Co	9551 Krouse Ovid, MI 48866	Bog and plant	Shiawassee.
Fletcher & Rickard	25800 Haas Rd. New Hudson, MI 48165	do	Oakland.
Hyponex Corp	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bogs and plants	Lapeer and Shiawassee.
Michigan Peat Co	Box 980129 Houston, TX 77098-0129	do	Sanilac.
Millburn Peat Co	Box 236 La Porte, IN 46350	Bog and plant	St. Joseph.
Perlite (expanded):			
Harborlite Corp	Box 458 Escondido, CA 92025	Plant	Kalamazoo.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Wayne.
Salines (natural):			
The Dow Chemical Co	2020 Dow Center Midland, MI 48640		
Ludington plant[5 6 7]		Brine wells and plant	Mason.
Midland plant[7]		do	Midland.
Martin Marietta Corp., Magnesia Specialties Div.[7]	Executive Plaza II Hunt Valley, MD 21030	do	Manistee.
Morton Thiokol Inc.[7]	110 North Wacker Dr. Chicago, IL 60606	do	Do.
Wilkinson Chemical Corp.[5 6]	8290 Lapeer Rd. Mayville, MI 48744	do	Lapeer.
Salt:			
Diamond Crystal Salt Co	916 South Riverside St. Clair, MI 48079	Brine wells and plants	Manistee and St. Clair.
Morton Thiokol Inc	110 North Wacker Dr. Chicago, IL 60606	Brine wells and plant	Manistee.
Sand and gravel:			
Construction (1986):			
American Aggregates Corp	Drawer 160 Greenville, OH 45331	Pits and plants	Kalamazoo, Livingston, Macomb, Oakland.
Blount Materials Corp	Box 1468 Saginaw, MI 48605	do	Oakland and Osceola.
Holloway Sand & Gravel Co. Inc	29250 Wixom Rd. Wixom, MI 48096	do	Lapeer, Oakland, Washtenaw.
Edward C. Levy Co.:			
Lyon Sand & Gravel Co	4780 South Hill New Hudson, MI 48165	do	Oakland.
Milford Sand & Gravel Co	do	do	Do.
Natural Aggregates Corp	65545 Mound Rd. Romeo, MI 48065	do	Livingston and Macomb.
Portable Aggregates Producers Inc.	1401 Souter Blvd. Troy, MI 48084	do	Livingston and Oakland.
Bill Smith Sand & Gravel Inc	Box 23 Otsego, MI 49078	do	Allegan.
Thomson Sand & Gravel Inc	48399 West Seven Mile Rd. Northville, MI 48167	Pit and plant	Wayne.
Whittaker & Gooding Co	5800 Cherry Hill Rd. Ypsilanti, MI 48197	Pits and plants	Lapeer and Washtenaw.

See footnotes at end of table.

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Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Industrial:			
Cheyenne Sand Corp., a subsidiary of Construction Aggregates Corp.	Box 68 Ferrysburg, MI 49409	Pits and plants	Ottawa.
Manley Bros. of Indiana Inc	Box 538 Chesterton, IN 46304	do	Berrien and Van Buren.
Nugent Sand Co. Inc	Box 1209 Muskegon, MI 49443	do	Muskegon.
Sand Products Corp	1938 First National Bldg. Detroit, MI 48226	do	Mackinac and Oceana.
Sargent Sand Co	Box 6280 Saginaw, MI 48603	do	Mason, Tuscola, Wexford.
U.S. Silica Co	20837 North Huron River Dr. Rockwood, MI 48173	Pit and plant	Wayne.
Slag—iron and steel:			
International Mill Service Co	1818 Market St. Philadelphia, PA 19103	Plant	Monroe.
Edward C. Levy Co	8800 Dix Ave. Detroit, MI 48209	Plants	Wayne.
Stone:			
Crushed:			
Limestone-dolomite:			
Drummond Dolomite Inc., a division of Bethlehem Steel Corp.	Martin Tower Bethlehem, PA 18016	Quarry and plant	Chippewa.
The France Stone Co	Box 1928 Toledo, OH 43603	do	Monroe.
Inland Lime & Stone Co., a division of Inland Steel Co.	Gulliver, MI 49840	Quarries and plants	Mackinac and Schoolcraft.
Michigan Foundation Quarry Co. Inc.	110 West Jefferson Ave. Trenton, MI 48183	Quarry and plant	Wayne.
Michigan Limestone Operations Ltd. Partnership.	Rogers City, MI 49779	Quarries and plants	Mackinac and Presque Isle.
Presque Isle Corp	Box 426 Alpena, MI 49707	Quarry and plant	Presque Isle.
Rockwood Stone Co. Inc	Box 113 Rockwood, MI 48173	Quarries and plants	Monroe and Wayne.
Stoneco Inc	Box 29A Maumee, OH 43603	do	Monroe.
Marl:			
Poehlman & Son	Route 2 Cassopolis, MI 49031	Pit	Cass.
Quartzite:			
A. Lindberg & Sons Inc	560 Mather Ave. Ishpeming, MI 49849	Quarry and plant	Marquette.
Traprock:			
Houghton County Road Commission.	Box 269 Hancock, MI 49930	do	Houghton.
Dimension:			
Limestone-dolomite:			
Inwood Stone Products Co	Box 24 Cooks, MI 49817	do	Schoolcraft.
Sandstone:			
Jude Stone Quarry Co	338 Austin Rd. Napoleon, MI 49261	do	Jackson.
Sulfur (recovered):			
Marathon Oil Co	1300 South Fort St. Detroit, MI 48217	Elemental sulfur recovered as a byproduct of oil refining.	Wayne.
Shell Western E&P Inc	Box 1523 Houston, TX 77251	do	Manistee.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Wayne.

[1]Also clays.
[2]Also crushed limestone.
[3]Also silver.
[4]Also iron oxide pigments.
[5]Also bromine.
[6]Also calcium chloride.
[7]Also magnesium compounds.

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The Mineral Industry of Minnesota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Mineral Resources Research Center, University of Minnesota, for collecting information on all nonfuel minerals.

By James J. Hill[1]

Minnesota's nonfuel mineral production was valued at $1.1 billion in 1987, about $15 million higher than in 1986. The State ranked eighth nationally in nonfuel mineral production value, falling from the sixth place it held in 1986. Production increased for all commodities except clays and lime. Minnesota led the Nation in iron ore production, accounting for about 72% of the total U.S. output. Shipments of iron ore, the State's leading mineral commodity, increased by nearly 4.9 million long tons. Output still lagged behind historic levels because of the late (mid-May) startup of USX Corp.'s Minntac facility following settlement of its nationwide labor dispute on February 1 and the continued bankruptcy closure of Reserve Mining Co.'s operations at Babbitt and Silver Bay. Total value of iron ore shipments was slightly lower because of cost-cutting measures of the iron industry that lowered the price of taconite pellets by $5.26 per long ton.

Table 1.—Nonfuel mineral production in Minnesota[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	e$5	NA	e$5	NA	$40
Iron ore (usable) thousand long tons, gross weight	34,977	1,430,353	28,779	1,017,261	33,654	1,012,788
Peat thousand short tons	34	1,720	W	W	30	W
Sand and gravel:						
Construction do.	e25,000	e55,500	24,055	53,116	e25,200	e67,400
Industrial do.	884	16,910	W	W	W	W
Stone:						
Crushed do.	7,756	22,601	e8,300	e26,300	8,995	29,246
Dimension do.	37	13,598	e28	e10,507	41	12,976
Combined value of clays, lime, and values indicated by symbol W	XX	r7,272	XX	20,438	XX	20,308
Total	XX	r1,547,959	XX	1,127,627	XX	1,142,749

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Minnesota in 1986, by county[1]

County	Minerals produced in order of value
Aitkin	Sand and gravel (construction), peat.
Becker	Sand and gravel (construction).
Beltrami	Do.
Benton	Do.
Big Stone	Do.
Blue Earth	Do.
Brown	Sand and gravel (construction), clays.
Carlton	Sand and gravel (construction), peat.
Carver	Sand and gravel (construction).
Cass	Do.
Chippewa	Do.
Chisago	Do.
Clay	Sand and gravel (construction), lime.
Clearwater	Sand and gravel (construction).
Cook	Do.
Cottonwood	Do.
Crow Wing	Do.
Dakota	Do.
Dodge	Do.
Douglas	Do.
Faribault	Do.
Freeborn	Do.
Goodhue	Do.
Hennepin	Do.
Houston	Do.
Hubbard	Do.
Isanti	Do.
Itasca	Iron ore, sand and gravel (construction).
Jackson	Sand and gravel (construction).
Kanabec	Do.
Kandiyohi	Do.
Kittson	Do.
Koochiching	Do.
Lac qui Parle	Do.
Lake	Do.
Lake of the Woods	Do.
Le Sueur	Sand (industrial), sand and gravel (construction).
Lincoln	Sand and gravel (construction).
Lyon	Do.
McLeod	Do.
Mahnomen	Do.
Marshall	Do.
Martin	Do.
Meeker	Do.
Mille Lacs	Do.
Morrison	Do.
Mower	Do.
Murray	Do.
Nicollet	Do.
Norman	Do.
Olmsted	Do.
Otter Tail	Sand and gravel (construction), peat.
Pennington	Sand and gravel (construction).
Pine	Do.
Pipestone	Do.
Polk	Lime, sand and gravel (construction).
Pope	Sand and gravel (construction).
Ramsey	Do.
Red Lake	Do.
Redwood	Clays, sand and gravel (construction).
Renville	Lime, sand and gravel (construction).
Rice	Sand and gravel (construction).
Rock	Do.
Roseau	Do.
St. Louis	Iron ore, sand and gravel (construction), peat.
Scott	Sand and gravel (construction), sand (industrial).
Sherburne	Sand and gravel (construction).
Sibley	Do.
Stearns	Do.
Steele	Do.
Stevens	Do.
Swift	Do.
Todd	Do.
Wabasha	Do.
Wadena	Do.
Waseca	Do.
Washington	Sand and gravel (construction), sand (industrial).
Watonwan	Sand and gravel (construction).
Wilkin	Do.
Winona	Do.
Wright	Do.
Yellow Medicine	Do.
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Trends and Developments.—Minnesota's legislators adopted a Mineral Resources Diversification Program that was contained in the Rural and Economic Development Act of 1987. It declared the policy of the State was to "Diversify the State's mineral economy through long-term support of mineral exploration, evaluation, development, production, and commercialization."

A Minerals Coordinating Committee was established to draw up a minerals diversification plan that had to be submitted to the legislature by December 31, 1987. The 10-year plan was to include strategy to (1) increase the knowledge of the State's mineral potential, (2) stimulate development of the State's mineral resources, and (3) promote basic minerals research.

Topics included in the plan, although not all-inclusive, ranged from aeromagnetic studies, bedrock geochemistry, reclamation studies, ferrous mineral research, and ore deposit modeling, to basic mineral research. The plan also included funding priorities for a 2-year period that would be updated and submitted to the legislature by January 15 of each odd-numbered year.

Employment.—The Research and Statistics Office of the Minnesota Department of Jobs and Training reported total mining employment of 6,000 persons in 1987, down from 6,500 persons in 1986. Metal mining employment fell to 4,300 workers from 4,600 workers in 1986. Average hourly wages in total mining were $12.96, 11 cents per hour lower than in 1986. Workers in metal mining averaged $14.10 per hour, 19 cents per hour lower than in 1986. Average hours worked per week was 42.5 for both total mining employment and metal mining employment.

Exploration Activities.—Mining company interest in Minnesota's mineral resource base accelerated during 1987 because of several positive actions taken by State agencies. The State's complex mining tax laws were revised to provide a more favorable environment for mining investment. A minerals diversification plan was developed to provide a 10-year strategy for State agency research that could lead to further development of Minnesota's nonferrous and industrial mineral base. Mining leases were also awarded during the year in areas where State agencies had discovered gold and platinum-group-metals mineralization. In May, a State agency announced another find of platinum-group-metals mineralization that expanded this area of interest.

At the end of 1987, 574 State metallic mineral leases were held by 26 mining firms in 9 counties, covering in excess of 230,000 acres.

Exploration drilling continued during the year with emphasis on precious metals—gold in the Archaean greenstone belts and platinum-group metals in the Proterozoic Duluth Gabbro Complex. One or more companies also searched for diamond-bearing kimberlite deposits in central Minnesota, kaolin near Redwood Falls, and manganese in the southwestern part of the State. Twenty-one companies were registered to conduct exploration drilling in 1987. Of these, eight companies actually drilled holes. Eighty-one holes were drilled in 10 counties for a total of 23,452 feet. One hole of 791 feet was drilled in St. Louis County by the Department of Natural Resources (DNR), Minerals Division, as part of its mineral evaluation program. Also, the Minerals Division drilled 38 overburden holes totaling 4,787 feet. These holes filled in between Rotasonic holes drilled in 1985, in which traces of gold were found. A summary of drilling activity is shown in table 3.

Table 3.—Minnesota: Exploration drilling in 1987, by county

County	Number of drill holes	Total footage drilled	Company or agency
Clay	1	226	Exmin Corp.
Cottonwood	2	360	BHP-Utah International Inc.
Itasca	41	7,654	FMC Corp. and Normin Mining Co.
Koochiching	7	3,061	Kerr-McGee Corp. and Normin Mining Co.
Morrison	2	294	Exmin Corp.
Redwood	3	594	BHP-Utah International Inc.
Roseau	2	1,405	Newmont Exploration Ltd.
St. Louis	19	8,800	Chevron U.S.A. Inc., Kerr-McGee Corp., Newmont Exploration Ltd., Rhude & Fryberger Inc.
Wilkin	2	583	Exmin Corp.
Yellow Medicine	2	475	BHP-Utah International Inc.
Total	81	23,452	

Source: Minnesota Department of Natural Resources, Division of Minerals, Hibbing, MN.

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Legislation and Government Programs.—Several pieces of legislation specific to the mining industry were enacted into law during the 1987 session. Chapter 286, the Omnibus Tax Bill, made extensive changes in the taxation of mining operations for minerals other than iron ore or taconite. Repealed were the State's ad valorem tax, which was placed on the value of ore in the ground, and the occupation tax. Instead, mining companies began to be taxed at the corporate income tax rate, which was reduced to 9.5% in 1987. The royalty tax which mining companies paid on private leases was repealed. Instead, recipients of royalties would be taxed at the income tax rate. Special taxes on copper-nickel mining also were repealed. A new net proceeds tax became effective on January 1, 1987: 2% of the gross proceeds from mining, less deductions for mining costs. This tax would apply to all mined minerals except iron ore and taconite.

The Minnesota constitution prohibits changes in the ways iron ore and taconite companies are taxed before November 4, 1989. Effective January 1, 1990, the occupation tax will be repealed for these operations and the corporate income tax imposed. Royalty taxes and ad valorem taxes also will be repealed. The production tax on taconite operations will continue. Taconite railroad taxes will be repealed, and the railroads will be subject to local property taxes.

Chapter 404, the State Departments Bill, provided funding for State agency mineral programs for fiscal years 1987 and 1988. Among the programs funded were geophysical studies with followup drilling, clay investigations and testing, and investigations concerning the potential of extracting high-value products from peat. Funding also was provided for a core library building at DNR's Minerals Division headquarters in Hibbing.

Chapter 386, The Rural and Economic Development Act, contained two articles pertaining to the State's mineral industry. Article 7 defined the State's mineral policy, established a minerals coordinating committee to plan for diversified mineral development, and addressed programs to be initiated. Also, $500,000 in funding was provided for both fiscal years 1988 and 1989 to accelerate geologic mapping and evaluation of the State's mineral potential.

Article 8 appropriated $4 million from the State's general fund to be used by the Commissioner of the Iron Range Resources and Rehabilitation Board to promote the economic health of the Iron Range Tax Relief Area. The money was to be used to provide loans, loan guarantees, interest buy-downs, and other forms of participation with private sources in projects that encourage diversification of the region's economy. These projects could provide permanent employment opportunities in the development of minerals, energy sources using indigenous fuels, forestry, small business, and tourism.

The Minnesota Geological Survey (MGS) continued its long-term bedrock-mapping projects at a 1:24,000 scale in northeastern Itasca County and along the North Shore of Lake Superior. The North Shore mapping was part of the U.S. Geological Survey's Cooperative Geological Mapping (COGEOMAP) program. Drilling programs were conducted in north-central and west-central Minnesota to aid in geologic mapping. A high-resolution aeromagnetic surveying program continued into its fifth biennium with mapping occurring in the northwestern and southwestern corners of the State. Studies also were initiated on the State's clay and graphite resources.

A multiagency investigation of Minnesota clay resources under the direction of the Mineral Resources Research Center (MRRC) at the University of Minnesota and sponsored by the Legislative Commission on Minnesota Resources (LCMR) focused on developing a data bank on the State's clay resources that may lead to expanded commercial development. The State's deposits and their characteristics will be defined by Natural Resources Research Institute (NRRI) personnel. Drilling would be undertaken by the MGS to supplement the deposit information. MRRC will investigate processing methods, especially for the low-grade kaolin clays in the Redwood Falls area. DNR personnel will conduct marketing and environmental studies.

MRRC continued work to develop a concentrate from two northern Minnesota ilmenite deposits and to determine the feasibility of producing a high-grade synthetic rutile slag by plasma reduction or directly chlorinating the ilmenite concentrates. MRRC's Quantitative Estimation of Materials using Scanning Electron Microscopy (QEM-SEM) laboratory came on-stream in 1986. Studies were made on various concentrate streams of taconite ores and their grade/liberation characteristics. Work was also performed on Minnesota copper-nickel samples to identify their liberation charac-

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teristics and QEM-SEM applications for identifying platinum-group elements in mineral specimens and fire assay buttons.

Several mineral-related studies were in progress at the NRRI in Duluth. One study focused on providing a broad base of geochemical data to support the MGS's Archaean mapping program in Itasca County. Another study was evaluating the precious-metals content of the copper-nickel deposits in the Duluth Complex to see if they could be economically mined. A third study was establishing background geochemical values for rocks in the Duluth Complex to aid in determining if anomalous areas exist. Other projects concerned the horticultural use of peat, characterization of the clay resources in Minnesota, and the use of taconite for ceramic tile and taconite tailings as a sandblasting medium. Contract work at the Coleraine research facility was directed toward helping USX Corp. convert its Minntac Plant in Mountain Iron to fluxed pellet production as well as solving beneficiation problems.

Minnesota's DNR, Division of Minerals, continued developing basic information on the State's mineral potential. Projects included evaluation of drill core from the Duluth Complex for platinum-group metals, geochemistry of samples taken from overburden drilling, drilling and evaluation of core from the State's Archaean greenstone belts, glacial drift geochemistry, peatland mapping, and aggregate mapping, as well as the agency's obligations for mined-land reclamation and mineral land leasing.

The U.S. Bureau of Mines Twin Cities Research Center expended about $630,000 for contracts, grants, equipment, and services by Minnesota firms in fiscal year 1987. Also, about $420,000 was distributed to MRRC for generic research projects and as part of a program to assist the efforts of the research center to train engineers and scientists in mineral-related disciplines. The Bureau had several research projects in progress concerning the State's taconite industry. The studies concerned magnetic-belt-cobbing technology for upgrading coarse taconite ores, utilizing waste paper sludge as an iron ore binder and pellet porosity builder, and high-temperature properties of acid and flux pellets using organic binders. The Bureau published RI 9116, "Sampling, Characterization, and Evaluation of Midwest Clays for Iron Ore Pellet Bonding."

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Minnesota continued to be the leading iron ore producer in the Nation, accounting for 71% of the total U.S. shipments. Iron ore, the State's leading nonfuel mineral commodity, accounted for nearly 89% of the State's total mineral value. All production was from the Mesabi Range—Itasca and St. Louis Counties. Shipments of iron ore increased nearly 17% in 1987 because of increased demand from the Nation's steel producers, who were helped by the Voluntary Restraint Agreement (VRA) program and the lower value of the dollar against other nations' currencies, which in turn reduced steel imports. Total value of the State's iron ore shipments declined slightly from that of 1986 because of increased efficiencies initiated by the iron ore producers that lowered unit costs.

Taconite pellets were shipped from six active plants in 1987 and from stockpiles at the inactive Reserve Mining Co. property at Silver Bay and from the closed Butler operation. Shipments of natural iron ore concentrates were reported from one active operation and two stockpiles.

Table 4.—Minnesota: Production and shipments of usable iron ore[1]

(Thousand long tons, gross weight, unless otherwise specified)

Year	Production				Shipments			
	Natural ore and concentrates	Pellets	Total[2]	Iron content (percent)	Natural ore and concentrates	Pellets	Total[2]	Proportion of pellets to total ore (percent)
1983	865	25,390	26,255	64.4	1,113	29,586	30,699	96.4
1984	853	35,844	36,697	64.7	1,193	34,409	35,602	96.7
1985	1,462	33,448	34,910	64.2	1,458	33,519	34,977	95.8
1986	r1,160	25,882	r27,042	64.4	1,345	27,435	28,779	95.3
1987	1,492	32,153	33,645	64.4	1,637	32,016	33,654	95.1

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[1]Exclusive of ore containing 5% or more manganese.
[2]Data may not add to totals shown because of independent rounding.

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Table 5.—Salient statistics for ports shipping Minnesota iron ore

Year, port, and dock	Date of first shipment	Date of last shipment	Number of shipments	Total shipments (gross tons)	Average shipment (gross tons)	Largest shipment (gross tons)
1986:						
Duluth, MN: DM&IR	Apr. 5	Dec. 24	163	5,034,790	30,888	63,781
Silver Bay, MN: Reserve	Apr. 12	July 15	26	1,449,669	55,757	63,324
Superior, WI: Burlington-Northern	Apr. 8	Dec. 24	195	8,998,170	46,144	64,390
Taconite Harbor, MN: Erie	Apr. 11	Dec. 28	135	5,456,744	40,420	63,587
Two Harbors, MN: DM&IR	Apr. 1	Dec. 14	135	6,155,788	45,598	63,288
Total or average			654	27,095,161	41,430	64,390
1987:						
Duluth, MN: DM&IR	Mar. 28	Dec. 25	237	7,595,375	32,048	61,739
Silver Bay, MN: Reserve[1]	NA	NA	4	182,603	45,651	NA
Superior, WI: Burlington-Northern	Mar. 24	Jan. 7	268	11,313,051	42,213	62,061
Taconite Harbor, MN: LTV	Mar. 31	Jan. 6	175	7,899,067	45,138	62,096
Two Harbors, MN: DM&IR	Apr. 2	Jan. 14	159	7,121,685	44,790	61,863
Total or average			843	34,111,781	40,465	62,096

NA Not available.
[1]Operations ceased after LTV Steel Co., co-owner of Reserve Mining Co., filed for bankruptcy on July 17, 1986. All stockpiled pellets remaining at Silver Bay were shipped out in October and November 1987.

Source: Annual Reports of Lake Carriers' Association, 1986 and 1987.

Union workers at Eveleth Mines, managed by Oglebay Norton Co., took cuts in wages and benefits totaling $1.62 per hour under a new 34-month contract that became effective July 1. Armco Inc. and Rouge Steel Co., part owners in the operation, had threatened to cancel their pellet orders if overall costs were not reduced. During 1987, stripping began at the Spruce Hill Reserve that will be mined in 1988-89. Several houses on leased land were removed and a county highway rerouted. Also, hearings were held on the company's proposal to extend its North Pit northward toward the city of Virginia which will allow for the extraction of 210 million long tons of crude taconite over the next 50 years.

Hibbing Taconite Co., managed by the Pickands Mather subsidiary of Cleveland Cliffs Inc., resumed operations on January 4 after a planned shutdown that began on November 6, 1986. Production was set at 5.5 million tons with two of the plant's three furnaces operating. In April, company officials announced that the third furnace would come on line and the plant would produce at its full capacity of 9 million tons. Between 40 and 100 laid-off employees were recalled at that time.

Inland Steel Mining Co. successfully completed the conversion of its Minorca plant to all fluxed pellet production during 1987. Stone for the pelletizing operation is mined at Inland Lime & Stone Co.'s quarry at Gulliver, MI, and shipped by lake vessel to Duluth where it is unloaded and transshipped by rail to the Minorca Mine. About 250,000 short tons of fluxstone was expected to be shipped to the mine annually.[2]

Erie Mining Co., which became a wholly owned subsidiary of LTV Steel Co. in May 1986, was renamed LTV Steel Mining Co. in February so it could be more readily identified as a member of LTV's family of companies. At the end of July, the company brought on-line a silica flotation circuit at its beneficiating facilities at Hoyt Lakes. The low-silica concentrates were to be used in the production of fluxed pellets. The Hoyt Lakes operation was shut down for a 5-week period between June 21 and July 26 for vacations and maintenance.

LTV Steel Co.'s Northwest Ore Div. established a record-high production at its McKinley Extension Mine near Aurora in 1987, shipping nearly 1.2 million tons of sinter fines and coarse ore products. The McKinley was the only active natural ore mine on the Mesabi Range.

Operations at National Steel Pellet Co. facilities at Keewatin, managed by The M. A. Hanna Co., were suspended for 8 weeks on June 7: a 3-week maintenance period and a 5-week vacation period. During this time, a computerized precision weighing system for rail cars was installed at the pellet loadout facility. In November, union workers ratified a new 21-month contract that called for a wage freeze and cuts in Sunday premium pay and vacation pay. Workers gained a profit-sharing plan, improvements in pension benefits, and limits on outside contractors.

The 6-month nationwide contract dispute involving USX Corp. steelworkers was resolved on February 1. Workers at the USS Div. Minntac plant in Mountain Iron returned to work during the week of May

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17. About 400 persons were placed on layoff status at the time of the callback, dropping employment at the facilities to about 1,200 persons. Experimental work on fluxed pellets began when the plant resumed operations in May. One line in the plant had been converted to fluxed pellet production before the work stoppage began in August 1986. In October, USS announced that it would invest $8 million to convert the Minntac plant to fluxed pellet production. The conversion was expected to be completed in 1988. A small percentage of acid pellets would be produced for customers that could not use fluxed pellets.

INDUSTRIAL MINERALS

Clays.—Two companies mined clay during 1987. Ochs Brick & Tile Co. mined common clay in Brown County and low-grade kaolin clay in Redwood County for brick manufacture. Northwestern States Portland Cement Co. mined a low-grade kaolin clay in Redwood County for manufacturing cement at its plant in Mason City, IA. Production declined slightly during the year because lesser quantities were used in cement manufacture.

Minnesota's clays came under increased scrutiny during 1987 when several State agencies initiated studies under the State's new mineral diversification program to examine (1) the extent of the kaolin clay resources in the Minnesota River Valley, (2) deposit characteristics, (3) clay quality, and (4) processing and beneficiation techniques. Georgia Kaolin Co. conducted drilling and feasibility studies in the Redwood Falls area to evaluate the area's kaolin resources for use in high-grade paper manufacture.

Lime.—Production and value of lime declined 15% and 24%, respectively. All of the State's lime was produced by two sugar-beet-processing companies that import limestone for their kilns from out-of-State sources. During the year, Pfizer Inc. began construction on a $10 million precipitated calcium carbonate plant at Potlatch Corp.'s Northwest Paper Div. mill in Cloquet, which was expected to start up in the second quarter of 1988. The plant will use lime from out-of-State sources, and its output will be used by Potlatch in the coating and filling of high-grade paper.

Peat.—Minnesota continued to rank sixth nationally in peat sales. Six companies harvested peat from bogs in Aitkin, Carlton, Otter Tail, Rice, and St. Louis Counties. Sales and value of sales increased moderately. Most of the State's peat production was the reed-sedge type with lesser quantities of sphagnum and hypnum. Peat was mainly sold for general soil improvement and as an ingredient for potting soil.

The NRRI at Duluth continued to work with Minnesota Sphagnum Inc. and Peat Associates of America who were developing bogs for production near Floodwood and Aitkin, respectively, in St. Louis County. Research personnel were involved in resource assessment, environmental permitting, production systems design, and quality control. The institute was also assisting St. Louis and Koochiching Counties with the development and promotion of their peatlands. Minnesota Sphagnum began construction of its processing facility near Floodwood that was expected to be in production in 1988.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Sand and gravel for construction purposes was the State's second-leading mineral commodity in terms of value, following iron ore. Production was estimated to have increased nearly 5% to 25.2 million short tons in 1987. Value of the State's production was estimated at $67.4 million. Average unit price increased by $0.46 per short ton. In November, Minnesota's second largest sand and gravel producer, J. L. Shiely Co. of St. Paul, agreed to be acquired by English China Clays PLC of the United Kingdom for $73 million. The sale was expected to be closed in early January of 1988.

Industrial.—Sand for industrial purposes was produced by two companies with operations in Le Sueur, Scott, and Washington Counties. Production and value increased about 9% and 28%, respectively. In descending order, sand was sold for hydraulic fracturing, manufacture of glass containers, sandblasting, foundry molding and core, engine traction, roofing granules, and other miscellaneous uses. Unimin Corp.'s sand-mining operations near Ottawa came under scrutiny during the year when a local citizens group presented a formal request to the Le Sueur County Board of Commissioners to tighten restrictions on the company's conditional use permit. The group wanted restrictions on operating and hauling hours and blasting, and requested that the company be required to prepare a detailed rec-

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lamation plan. The controversy was not resolved before yearend.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Production of crushed stone was nearly 9 million short tons in 1987, the highest output since 1979. Value of production increased about 11% to $29.2 million. Stone was quarried and crushed by 31 companies at 69 sites in 16 of the State's 87 counties. Limestone-dolomite accounted for most of the State's production, followed by granite. Sandstone, traprock, and quartzite rocks were also quarried but in lesser volume.

Table 7 presents end-use data for crushed stone produced in the six Minnesota districts depicted in figure 1.

Table 6.—Minnesota: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	230	958
Filter stone	101	385
Coarse aggregate, graded:		
Concrete aggregate, coarse	578	2,007
Bituminous aggregate, coarse	176	714
Bituminous surface-treatment aggregate	376	1,344
Railroad ballast	835	2,171
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	207	680
Screenings, undesignated	59	249
Coarse and fine aggregates:		
Graded road base or subbase	3,361	10,569
Unpaved road surfacing	314	954
Other construction[2]	293	1,162
Agricultural: Agricultural limestone	250	851
Special: Other miscellaneous[3]	236	1,369
Other unspecified[4]	1,978	5,883
Total	[5]8,995	29,246

[1]Includes dolomite, granite, limestone, quartzite, sandstone, and traprock.
[2]Includes macadam, coarse aggregate (graded), terrazzo and exposed aggregate, and crusher run or fill or waste.
[3]Includes poultry grit and mineral food, other fillers or extenders, and waste materials.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.

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Table 7.—Minnesota: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	--	--	W	W	W	W
Coarse aggregate, graded[2]	--	--	W	W	W	W
Fine aggregate (-3/8 inch)[3]	--	--	--	--	W	W
Coarse and fine aggregates[4]	--	--	--	--	W	W
Other construction	--	--	--	--	--	--
Agricultural[5]	--	--	--	--	--	--
Special[6]	--	--	--	--	--	--
Other unspecified[7]	--	--	--	--	W	W
Total	--	--	W	W	W	W

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	83	402	306	1,112	9	23
Coarse aggregate, graded[2]	(8)	(8)	755	2,414	89	312
Fine aggregate (-3/8 inch)[3]	90	439	(8)	(8)	--	--
Coarse and fine aggregates[4]	(8)	(8)	3,071	9,861	431	1,283
Other construction	446	1,891	133	557	2	6
Agricultural[5]	44	204	164	477	64	288
Special[6]	--	--	(9)	(9)	--	--
Other unspecified[7]	--	--	444	1,964	1,643	4,858
Total	[10]664	2,936	4,873	16,385	2,238	6,770

W Withheld to avoid disclosing individual company proprietary data.
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, and coarse aggregate (graded).
[3]Includes stone sand (bituminous mix or seal) and fine aggregate (screenings).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[5]Includes agricultural limestone and poultry grit and mineral food.
[6]Includes other fillers or extenders and waste material.
[7]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[8]Withheld to avoid disclosing company proprietary data; included with "Other construction."
[9]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[10]Data do not add to total shown because of independent rounding.

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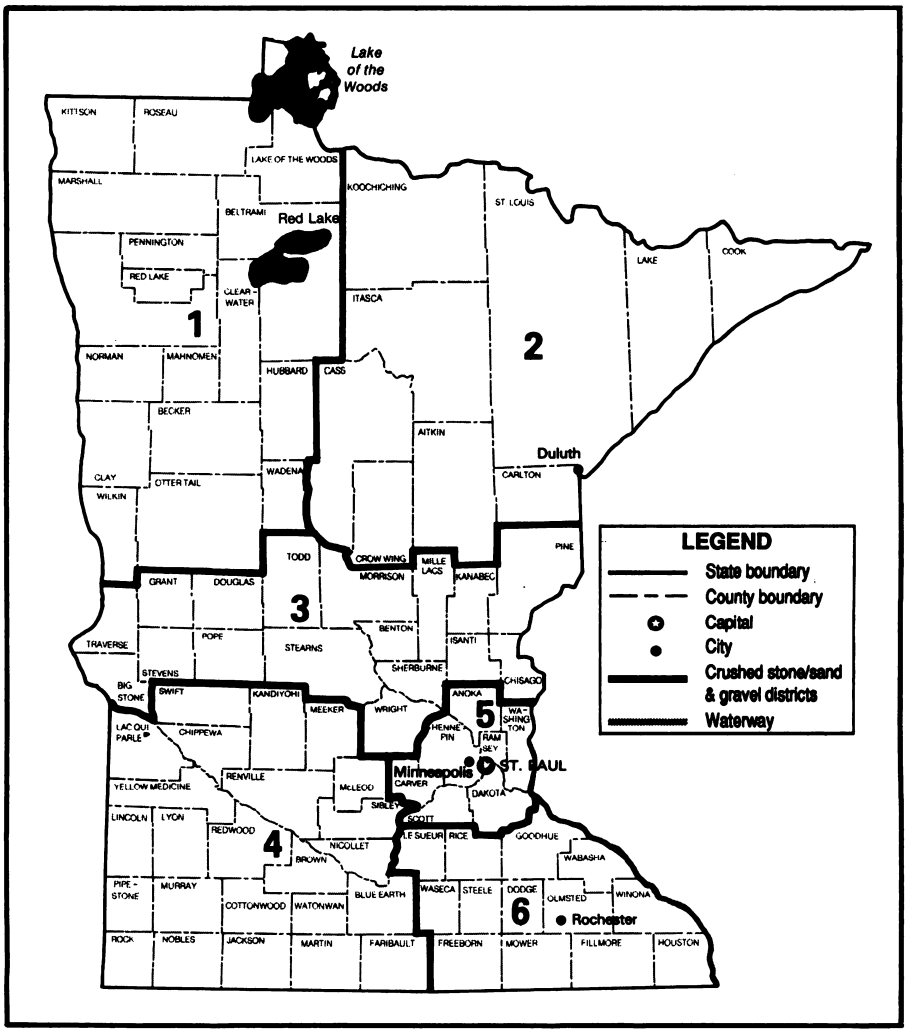

Figure 1.—Aggregate-producing districts in Minnesota.

In November, J. L. Shiely, the State's largest producer of crushed stone, agreed to be acquired by English China Clays of the United Kingdom. Shiely operated two stone quarries in Scott and Washington Cour ies. Meridian Aggregates, a subsidiary of urlington Northern Inc., took over operations in December at the railroad's Granite Falls quarry that had been operated under contract by the Green Company of Washington State. In peak years, the quarry had produced as much as one million tons of crushed granite, mainly for railroad ballast.

Dimension.—Minnesota ranked 10th of 35 States in dimension stone production. Output and attendant value increased 46% and 23%, respectively, in 1987. Granite was quarried by two companies having operations in five counties. Limestone-dolomite was quarried by three companies in Blue

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Earth, Le Sueur, and Winona Counties. Dressed stone—slabs, blocks, veneer, and other partially squared pieces—made up 86% of the volume of stone sold and accounted for 90% of the total dollar value of sales. Other products sold included rough blocks and irregular-shaped stone, rough and dressed stone for monuments, curbing, and flagging.

Cold Spring Granite Co. of St. Cloud and two other U.S. stone producers petitioned the International Trade Commission (ITC), charging that Italian and Spanish dimension stone producers were dumping their products in the U.S. at unrealistic prices. On September 9, the ITC returned a preliminary finding that found "reasonable indication of injury" to U.S. manufacturers of granite products by the pricing policies of Italian and Spanish stone producers. The preliminary finding was the first step by the ITC to determine if the allegations were correct and whether duties should be imposed on imported granite products to protect U.S. manufacturers.

Other Industrial Minerals.—Gem stones and mineral specimens were estimated to have contributed $40,000 to the State's total nonfuel mineral value. Perlite from out-of-State sources was expanded at the USG Acoustical Products Co. plant near Cloquet. Sales and attendant value increased 30% and 37%, respectively. Sales of processed steel slag from North Star Steel Co.'s mill in St. Paul increased 84%. Most of the product was used as road base material. Lesser quantities were used in asphaltic concrete and as fill. Sales of sulfur recovered as a byproduct at Minnesota's two refineries declined about 3%. Average price dropped $5.33 per metric ton. W. R. Grace & Co. continued to exfoliate vermiculite from out-of-State sources at its plant in Minneapolis. Sales and attendant value declined 8% and 10%, respectively. Most of the sales were for loose-fill and block insulation. Lesser quantities were used in fireproofing and horticulture and as aggregate in concrete and plaster.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.

[2]Skillings, D. N., Jr. U.S. Iron Ore Industry To Recover Moderately in 1987 to Level of 45 Million Gross Tons of Pellets and Ore. Skillings' Min. Rev., v. 76, No. 30, July 25, 1987, pp. 14-23.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	Pit	Redwood.
Ochs Brick & Tile Co	Box 106 Springfield, MN 56087	Pits and plant	Brown and Redwood.
Iron ore:			
The M. A. Hanna Co.:	1301 East 9th St. Suite 3600 Cleveland, OH 44114-1824		
Butler Taconite Project		Stockpile shipments.	Itasca.
National Steel Pellet Project		Mine, concentrator, agglomerator.	Itasca and St. Louis.
Inland Steel Mining Co.:	30 West Monroe St. Chicago, IL 60603		
Minorca		do	St. Louis.
LTV Steel Co., Northwest Ore Div.:	Box 196 Aurora, MN 55705		
McKinley Extension		Mine and concentrator.	Do.
Oglebay Norton Co.:	1100 Superior Ave. Cleveland, OH 44114		
Eveleth Mines		Mine, concentrator, agglomerator.	Do.
Pickands Mather (a subsidiary of Cleveland-Cliffs Inc.):	1100 Superior Ave. Cleveland, OH 44114		
Hibbing Taconite Co		do	Do.
LTV Steel Mining Co		do	Do.
Reserve Mining Co		Stockpile shipments.	Lake.
Pittsburgh Pacific Co:	2521 1st Ave. Hibbing, MN 55746		
Connie		do	St. Louis.
Rhude & Fryberger Inc.:	Box 66 Hibbing, MN 55746		
Rana		Stockpile and plant.	do

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Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iron ore—Continued			
USX Corp., Minnesota Ore Operations:	Box 417 Mountain Iron, MN 55768		
Minntac	----------	Mine, concentrator, agglomerator.	St. Louis.
Lime:			
American Crystal Sugar Co	101 North 3d St. Moorhead, MN 56560	Plants	Clay and Polk.
Southern Minnesota Sugar Coop	Box 500 Renville, MN 56284	Plant	Renville.
Peat:			
Aitkin Agri-Peat	Fleming Route, Box 35 Aitkin, MN 56431	Bog and plant	Aitkin.
Eli Colby Co	Box 248 Lake Mills, IA 50450	Bog	Rice.
Michigan Peat Co	Box 980129 Houston, TX 77098	Bog and plant	Carlton.
Peatrex	506 12th St. Cloquet, MN 55720	do	Do.
Power-O-Peat Co	Box 956 Gilbert, MN 55741	do	St. Louis.
Tamarack Peat Moss Co	Underwood, MN 56586	do	Otter Tail.
Perlite (expanded):			
USG Acoustical Products Co., a subsidiary of USG Corp.	Arch St. Cloquet, MN 55720	Plant	Carlton.
Sand and gravel:			
Construction (1986):			
Barton Contracting Co	10633 89th Ave. North Osseo, MN 55369	Pits and plants	Benton, Dakota, Hennepin, Sherburne, Washington, Wright.
Fairway Construction Co	Box 426 Hector, MN 55342	do	Various.
Lundin Construction Co. Inc	1905 Third Ave. Mankato, MN 56001	do	Carlton, Rice, Steele.
North Star Concrete Co	Box 167 Mankato, MN 56001	do	Le Sueur and Nicollet.
Prior Lake Aggregates Inc	8680 West 158th St. Prior Lake, MN 55872	Pit and plant	Scott.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	do	Washington.
Stommes Construction Co	Route 4 St. Cloud, MN 56301	Pits and plants	Hennepin, Hubbard, Sherburne, Stearns.
Industrial:			
Twin City Silica Ltd	499 Cottage Grove Dr. Woodbury, MN 55125	Pit and plant	Washington.
Unimin Corp	258 Elm St. New Canaan, CT 06840	Pits and plants	Le Sueur and Scott.
Slag—iron and steel:			
International Mill Service Co	1818 Market St. Philadelphia, PA 19103	Plant	Washington.
Stone:			
Crushed:			
Granite:			
Meridian Aggregates Co	Box 69 St. Cloud, MN 56301	Quarry and plant	Stearns.
Limestone-dolomite:			
Bryan Rock Products Inc	Box 215 Shakopee, MN 55379	Quarries and plants	Scott and Washington.
Hardrives Inc	7200 North Hemlock Lane Maple Grove, MN 55369	do	Scott.
Holm Brothers Construction Co.	Box 235 Goodhue, MN 55027	do	Goodhue and Wabasha.
Mankato Aglime & Rock Co	Box 254 Mankato, MN 56001	Quarry and plant	Blue Earth.
Mathy Construction Co., Patterson Quarries Div.	Route 3, Box 15 St. Charles, MN 55972	Quarries and plants	Houston, Olmsted Wabasha, Winona.
Midwest Asphalt Corp., River Warren Aggregates Inc.	Box 338 Hopkins, MN 55343	Quarry and plant	Scott.
Quarve & Anderson Co	2430 Marion Rd. SE. Rochester, MN 55901	Quarries and plants	Dodge, Goodhue, Olmsted.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	do	Scott and Washington.
Quartzite:			
New Ulm Quartzite Quarries Inc.	Route 5, Box 21 New Ulm, MN 56073	Quarry and plant	Nicollet.
Traprock (basalt):			
Arrowhead Blacktop Co	Box 6568 Duluth, MN 55806	do	St. Louis.

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Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone: —Continued			
Dimension:			
Granite:			
Cold Spring Granite Co	Cold Spring, MN 56320	Quarries	Big Stone, Mille Lacs, Renville.
Do		Quarries and plant	Stearns.
Field Granite International Ltd.	3434 Heritage Dr. Edina, MN 55435	Quarry and plant	Lac Qui Parle.
Limestone:			
Biesanz Stone Co. Inc	Box 768 Winona, MN 55987	do	Winona.
Minnesota Quarries Inc	Box 1358 Mankato, MN 56002	do	Blue Earth.
Vetter Stone Co	Route 5, Box 41 Mankato, MN 56001	Quarries and plant	Blue Earth and Le Sueur.
Sulfur (recovered):			
Ashland Petroleum Co., a division of Ashland Oil Inc.	Box 391 Ashland, KY 41101	Elemental sulfur recovered as a by-product of oil refining.	Washington.
Koch Refining Co., a division of Koch Industries Inc.	Box 2302 Wichita, KS 67201	do	Dakota.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Hennepin.

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The Mineral Industry of Mississippi

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Geology, Mississippi Department of Natural Resources, for collecting information on all nonfuel minerals.

By James R. Boyle[1]

The value of Mississippi's nonfuel mineral industry in 1987 increased by 9% to $110 million. Mississippi's economy remained one of the weakest in the Southeast; mineral output was relatively low.

Commodities produced included cement, clays, sand and gravel, and stone. Although not considered a major mining State, ranking 42d nationally, Mississippi ranked high in production of certain clays. Output of bentonite ranked second nationally while output of fuller's earth ranked sixth. The State also had two titanium dioxide plants and a small metals sector.

Table 1.—Nonfuel mineral production in Mississippi[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	1,558	$34,864	[2]928	[2]$13,538	1,123	$26,933
Gem stones	--	--	NA	1	NA	1
Sand and gravel (construction) thousand short tons	[e]13,400	[e]42,000	15,080	42,809	[e]14,700	[e]47,000
Stone (crushed) ----------do----	1,582	4,282	[e]1,600	[e]4,400	1,492	9,621
Combined value of cement, clays (ball clay and fuller's earth, 1986), and sand and gravel (industrial) ----------	XX	21,647	XX	40,347	XX	26,524
Total ----------	XX	102,793	XX	101,095	XX	110,079

[e]Estimated. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Mississippi in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel.
Benton	Clays.
Bolivar	Sand and gravel.
Carroll	Do.
Clay	Do.
Copiah	Do.
De Soto	Do.
Forrest	Do.
George	Do.
Hancock	Do.
Harrison	Do.
Hinds	Clays.
Holmes	Sand and gravel.
Itawamba	Do.
Jackson	Do.
Jasper	Do.
Jefferson Davis	Do.
Jones	Sand and gravel, clays.
Kemper	Clays.
Lafayette	Sand and gravel.
Lauderdale	Do.
Lee	Do.
Lincoln	Sand and gravel, clays.
Lowndes	Cement, sand and gravel, clays.
Marion	Sand and gravel.
Marshall	Clays.
Monroe	Clays, sand and gravel.
Noxubee	Clays.
Panola	Clays, sand and gravel.
Pearl River	Sand and gravel.
Perry	Do.
Pike	Do.
Stone	Do.
Tate	Do.
Tippah	Clays.
Tishomingo	Sand and gravel.
Walthall	Do.
Warren	Do.
Washington	Do.
Wayne	Do.
Winston	Clays.
Yalobusha	Sand and gravel.
Yazoo	Do.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—The unemployment rate, although decreasing, remained in double digits, ending the year at 10.2%. The minerals sector, however, did not participate in the general increase in employment. The construction industry, the main customer for the State's mineral output, declined slightly from its already low level. Mining employment decreased about 10%.

The Tennessee-Tombigbee Waterway handled over 4 million short tons of material in 1987, a 10% increase over that of 1986. Mineral commodities were the major material handled. Crushed stone accounted for the most tonnage, more than 800,000 short tons. Crushed stone was shipped to the coastal region and to storage yards along the waterway.

The Mississippi Department of Economic Development reported 1 new mineral operation and 14 expansions. Total investment was estimated in excess of $50 million. The new operation was a clay company and the expansions included eight clay, three sand and gravel, one mineral fiber, one stone, and one titanium dioxide plant.

Kerr-McGee Chemical Corp., Hamilton, combined a two-phase expansion at its titanium dioxide facility into one phase. The expansion, to be completed by mid-1989, will increase capacity to 106,000 short tons. Estimated cost for the expansion was $45 million. The company's synthetic rutile plant at Mobile, AL, provided feedstock for the Hamilton facility, using ore from Australia. Kerr-McGee also produced electrolytic manganese at Hamilton.

During fiscal year 1987, 215,000 short tons of ilmenite from Australia was imported through the Port of Gulfport, up from 196,000 tons in fiscal year 1986. The ilmenite was destined for the E. I. du Pont de Nemours & Co. Inc. titanium dioxide operation at Pass Christian.

Legislation and Government Programs.—The Mississippi Minerals Resources Institute (MRI) investigations dur-

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ing the year included testing of clays, basic geologic studies, beneficiation studies, and oil recovery investigations. MRI established an Underwater Minerals and Mining Technology Center that will be moved to Bay St. Louis. The basic charter of the center is to determine location and extent of offshore resources.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Industrial minerals accounted for all of Mississippi's nonfuel mineral production in 1987. Major commodities produced were cement, clays, sand and gravel, and stone.

Cement.—United Cement Co., Artesia, was the only cement producer in the State. Output of portland cement increased to its highest level since 1981; masonry cement output remained low.

Raw materials used in the manufacture of cement included anhydrite, chalk, gypsum, iron ore, limestone, and sand. Raw materials used were mined in the State or adjacent States with the product shipped to markets in the Southeast.

Clays.—Mississippi's clay industry consisted of 17 companies operating 23 mines in 11 counties primarily in the northern and northeastern parts of the State. Ball clay, bentonite, common clay, and fuller's earth were produced in the State. Mississippi ranked second nationally in output of bentonite and sixth in fuller's earth. Output of total clays increased over that of 1986, while value nearly doubled.

Common clay was mined at 16 pits primarily in Hinds, Kemper, and Noxubee Counties. Output was 560,000 short tons compared with 617,000 tons in 1986. Major uses were for brick, concrete block, and highway surfacing. Five companies that use common clay expanded facilities during the year: four brick and one ceramic tile plant. Ky-Tenn Clay Co., Panola County, was the only reported producer of ball clay in the State. The clay was used mainly in ceramic applications. Output and value increased 9.4% and 5.8%, respectively. Cyprus Industrial Minerals Co. reportedly mined ball clay intermittently and trucked the clay to Tennessee.

Mississippi's three bentonite producers operated pits in Monroe County. Demand decreased from that of 1986. American Colloid Co., Aberdeen, purchased Culligan USA's desiccant business and will relocate the operations from California to Aberdeen. KaiserTech Ltd. purchased Chevron Corp.'s 50% interest in Harshaw-Filtrol, making Kaiser sole owner of the company. Harshaw's principal operation in Jackson produced calcium bentonite products used in purification and in petrochemical refining. American Colloid and Filtrol announced expansions at their Aberdeen operations.

Production and value of fuller's earth decreased 32% from that of 1986. Three companies mined fuller's earth from open pits in Tippah County to produce various absorbent products. Oil Soak Inc., Noxubee County, started operations in midyear and expansed until yearend. The $2.8 million facility mined a montmorillonite from the Weyerhaeuser Pit to produce various absorbents.

Sand and Gravel.—Mississippi produced both construction and industrial sand and gravel in 1987. Total production was estimated to have decreased from that of 1986. Operations in the State were relatively small with no operation producing over 1 million tons in 1987.

Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. The data for odd-numbered years are based on annual company estimates.

Construction sand and gravel remained the leading commodity in value among the nonfuel minerals produced in Mississippi. Production and value decreased from that of 1986 while unit values increased. The decrease occurred because of reduced construction activities. The State's 10-year road construction program was not expected to have a significant impact on producers until the 1990's.

Industrial.—Industrial sand was produced by two companies in Jackson and Tishomingo Counties. Both output and value decreased slightly. Main use was in foundries and as a blasting sand.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual

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data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed stone output remained at about the same level as that of 1986. With the completion of the Tennessee-Tombigbee Waterway, markets were being supplied to some extent by out-of-State producers barging stone down the waterway. The one commercial crushed stone producer faced increased competition for decreasing markets from the out-of-State producers using storage yards along the waterway.

In 1987, seven companies produced limestone or marl at nine quarries in seven counties.

Table 3.—Mississippi: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate: Other construction[2]	614	1,968
Agricultural: Agricultural limestone	124	662
Special: Other unspecified[3]	754	6,992
Total	1,492	[4]9,621

[1]Limestone.
[2]Includes stone used as riprap and jetty stone, concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, screenings (undesignated), graded road base or subbase, and unpaved road surfacing.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

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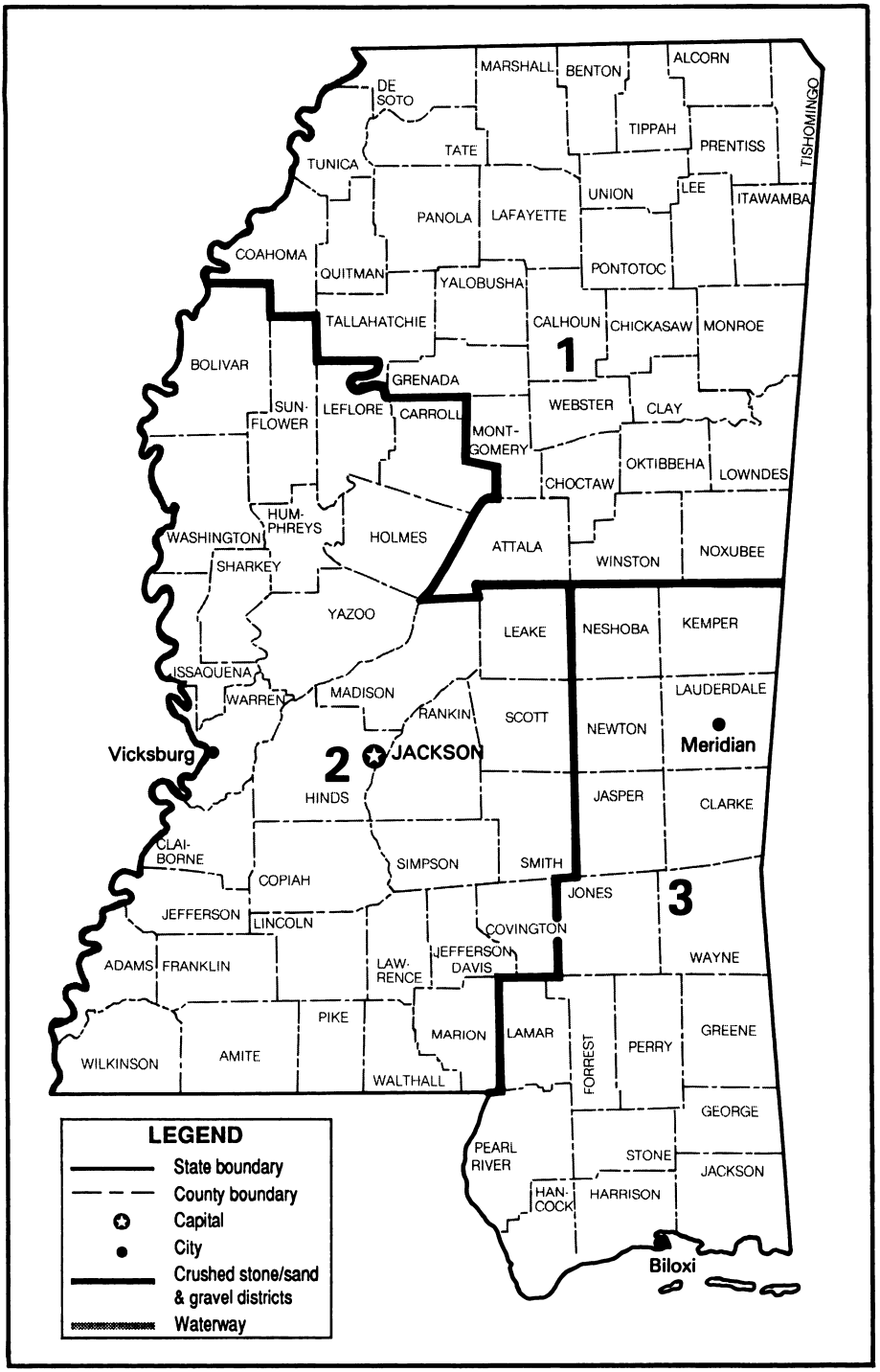

Figure 1.—Aggregate-producing districts in Mississippi.

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Sulfur (Recovered).—Mississippi ranked third in the Nation in output of recovered sulfur. Sulfur sold or used in 1987 totaled 780,000 metric tons, valued at $70.4 million, an increase of 10.3% in shipments and a decrease of 11.2% in value from that of 1986. Production of recovered sulfur from refinery and natural gases was reported by Shell Oil Co. in Clarke and Rankin Counties; Chevron USA Inc. in Jackson County; Amerada Hess Corp. in Lamar County; Pursue Gas Processing & Petrochemical Co. in Rankin County; and Koch Hydrocarbon Co. in Clarke County.

Other Industrial Minerals.—Corhart Refractories Co. Inc., Pascagoula, used imported chrome ore for the production of refractories. The primary use was in the form of chromite to make refractory brick for lining metallurgial furances. As a result of poor markets for steelmaking refractories, production ceased in May with plant closure in June. A total of 92 jobs was lost as a result of the closure. Mississippi ranked first nationally in the output of expanded perlite. Manville Products Corp., Natchez, and the USG Corp., Greenville, expanded perlite shipped from Western States. Production and value decreased.

METALS

Metal processing was not a significant industry in the State. Shipments of ferroalloys increased 5% while value increased 6%. Kerr-McGee operated an electrolytic manganese plant at Hamilton using ore from West Africa. According to Mississippi Research and Development Center, 11 companies produced aluminum castings, 8 produced gray iron castings, 8 produced brass castings, and 6 produced steel castings. In addition, three secondary nonferrous smelters operated in the State.

Birmingham Steel Corp.'s minimill in Jackson produced carbon steel bars using an electric arc furnace. It was the only minimill in Mississippi and the largest supplier of reinforcing bar in Mississippi and Louisiana.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
United Cement Co	Box 185 Artesia, MS 39736	Plant	Lowndes.
Clays:			
International Minerals & Chemical Corp	Box 346A Aberdeen, MS 39730	Mine	Monroe and Tippah.
Jackson Ready Mix Concrete, a division of Delta Industries Inc.	Box 1292 Jackson, MS 39205	do	Hinds.
Oil-Dri Production Co	Box 476 Ripley, MS 38663	Mine and plant	Tippah.
Presley Construction Inc	Box 46 Shuqualak, MS 39361	Mines	Noxubee.
Sand and gravel:			
American Sand & Gravel Co	Box 272 Hattiesburg, MS 39401	Stationary plant	Forrest.
Blain Gravel Co	Box 278 Mount Olive, MS 39119	Stationary plants	Clay, Copiah, Itawamba, Marion.
Hammett Gravel Co	Box 207 Lexington, MS 39095	Mines and plants	Holmes, Marion, Pike.
Stone (crushed, 1987):			
Mississippi Stone Products	Box 338 Iuka, MS 38852	Quarry	Tishomingo.
State Department of Agriculture and Commerce.	Box 1609 Jackson, MS 39205	Quarries	Clay, Noxubee, Wayne.
United Cement Co	Box 185 Artesia, MS 39736	Quarry	Lowndes.

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The Mineral Industry of Missouri

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Missouri Department of Natural Resources, Division of Geology and Land Survey, for collecting information on all nonfuel minerals.

By Leon E. Esparza,[1] Ardel W. Rueff,[2] and Heyward M. Wharton[3]

The value of nonfuel minerals produced in Missouri increased more than 15% in 1987 to about $863 million. The State ranked 10th in the Nation, the same ranking as in 1986. Missouri led the Nation in production of lead; it was second in lime and third in barite, iron ore, crude iron oxide pigments, and zinc.

Industrial minerals contributed nearly $539 million, or 62%, to the total nonfuel mineral value; cement, Missouri's leading industrial mineral product, accounted for

Table 1.—Nonfuel mineral production in Missouri[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite thousand short tons	47	$2,791	W	W	27	$2,030
Cement:						
Masonry do.	139	6,630	167	$7,816	167	10,027
Portland do.	3,669	159,757	4,642	179,184	5,110	185,317
Clays[2] do.	1,545	10,271	1,321	6,650	1,476	10,415
Copper (recoverable content of ores, etc.) metric tons	13,410	19,797	W	W	W	W
Gem stones	NA	e10	NA	W	NA	W
Iron ore (usable) thousand long tons, gross weight	1,110	W	803	W	744	W
Lead (recoverable content of ores, etc.) metric tons	371,008	155,955	319,900	155,481	W	W
Sand and gravel:						
Construction thousand short tons	e7,500	e20,000	9,746	24,065	e10,900	e30,400
Industrial do.	535	7,330	517	6,230	622	7,786
Silver (recoverable content of ores, etc.) thousand troy ounces	1,635	10,044	1,459	7,982	1,181	8,276
Stone:						
Crushed thousand short tons	50,646	162,097	e51,200	e170,500	54,910	184,824
Dimension do.	W	W	W	W	3	454
Zinc (recoverable content of ores, etc.) metric tons	49,340	43,908	37,919	31,767	34,956	32,306
Combined value of clays (fuller's earth), iron oxide pigments (crude), lime, and values indicated by symbol W	XX	136,370	XX	158,910	XX	391,206
Total	XX	734,960	XX	748,585	XX	863,041

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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almost 23% of the total. Production increased for portland cement, clays, lime, sand and gravel, and crushed stone. Recoverable lead production accounted for about 71% of the total value of metals mined in the State.

Table 2.—Nonfuel minerals produced in Missouri in 1986, by county[1]

County	Minerals produced in order of value
Audrain	Clays.
Bollinger	Sand and gravel (construction).
Boone	Do.
Butler	Sand and gravel (construction), clays.
Callaway	Do.
Camden	Sand and gravel (construction).
Cape Girardeau	Cement, sand and gravel (construction), clays.
Clark	Sand and gravel (construction).
Clay	Do.
Cole	Do.
Cooper	Do.
Crawford	Clays.
Daviess	Sand and gravel (construction).
Douglas	Do.
Franklin	Sand and gravel (construction), clays.
Gasconade	Clays, sand and gravel (construction).
Gentry	Sand and gravel (construction).
Greene	Lime.
Howard	Sand and gravel (construction).
Howell	Do.
Iron	Lead, copper, zinc, silver.
Jackson	Cement, sand and gravel (construction).
Jefferson	Cement, sand (industrial), sand and gravel (construction).
Lafayette	Sand and gravel (construction).
Lewis	Do.
Lincoln	Do.
Livingston	Clays, sand and gravel (construction).
McDonald	Sand and gravel (construction).
Macon	Do.
Miller	Do.
Montgomery	Clays, sand and gravel (construction).
Morgan	Sand and gravel (construction).
Nodaway	Do.
Oregon	Do.
Osage	Clays.
Ozark	Sand and gravel (construction).
Pemiscot	Do.
Phelps	Do.
Pike	Cement, clays, sand and gravel (construction).
Platte	Clays.
Pulaski	Sand and gravel (construction).
Ralls	Cement, clays.
Reynolds	Lead, zinc, copper, silver.
Ripley	Sand and gravel (construction).
St. Charles	Clays.
St. Francois	Lime, sand and gravel (construction).
Ste. Genevieve	Do.
St. Louis	Sand and gravel (construction), sand (industrial).
St. Louis City	Sand and gravel (construction).
Scott	Do.
Stoddard	Clays, sand and gravel (construction).
Taney	Sand and gravel (construction).
Texas	Do.
Warren	Clays, sand and gravel (construction).
Washington	Iron ore, lead, zinc, barite, copper, silver, sand and gravel (construction), iron oxide pigments.
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Trends and Developments.—Mining employment totaled about 5,500 and posted a decline of nearly 7% from that of 1986, according to the Missouri Department of Labor. The decline was partially attributed to decreased lead-zinc production and to reduced staff requirements resulting from the merger of the Fluor Corp.'s subsidiary St. Joe Minerals Div. and Homestake Mining Co.'s Missouri lead operations into The Doe Run Co. in late 1986. Most of Missouri's industrial minerals production is used in construction. Permits for private and public residential construction dropped more than 12% to 29,085 units in 1987. However, the value of nonresidential construction increased to almost $1.45 billion, or about 3%, according to the U.S. Department of Commerce. State road contract awards increased about 10% to $395 million.[4]

Legislation and Government Programs.—The U.S. Bureau of Land Management and the U.S. Forest Service issued a draft Environmental Impact Statement (EIS) and held public hearings concerning two preference-right lease applications that would allow continued minerals exploration. Doe Run petitioned for the leases in the Mark Twain National Forest, about 30 miles south of the Viburnum Trend. The final EIS, incorporating public comments, was scheduled to be available in late 1988. United States Steel Corp., now known as USX Corp., initially explored the area after permits were issued in November 1979. The permits were not legally renewable when they expired in November 1983. The lease applications pending at yearend held up additional exploration for minable deposits.

The Missouri Department of Natural Resources, Division of Geology and Land Survey, continued geologic studies focusing on mapping and collecting basic information of potential benefit for mineral resource studies by mining companies, government, and academia. Some of the work was done cooperatively with the U.S. Geological Survey.

Extractive metallurgical research was conducted at the U.S. Bureau of Mines Rolla Research Center. Research continued on improving technology and economics of recovering cobalt and nickel from Missouri lead ores. In September, the Bureau of Mines cobalt recovery process was selected for one of 100 national I-R 1987 Awards sponsored by R&D Magazine. The process uses stepwise flotation to remove most of the copper and lead compounds in the process stream and then concentrates the remaining cobalt to grades greater than those of cobalt concentrates from Africa. The cobalt recovery process would be an add-on to existing plants and would not interfere with existing processes. In Missouri, about 500,000 pounds of cobalt are contained in the annual production of copper concentrates.

The research center also sought improvements in base-metal leach systems, using an oxidative leaching method in combination with electrowinning technology. Research was directed toward treatment of toxic heavy metals dissolved in impoundments such as tailings ponds, irrigation drainage areas, and industrial and municipal waste-settling ponds. Research focused on a high-technology, low-voltage system for electrowinning trace elements from solution.

The Mining and Mineral Resources Research Institute of the University of Missouri received $569,018 from the U.S. Bureau of Mines for fiscal year 1987. Among the institute's objectives are basic and applied research related to the State's mineral resources for the general benefit of the Nation's mineral industry.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Barite.—Missouri ranked third among six States producing barite. Production continued to decrease, because of continued low levels of oil drilling. Barite is used extensively by the petroleum industry as a drilling-mud additive to prevent blowouts in wells. Other uses are in pigments and fillers for paint and rubber and in barium chemical manufacturing.

Cement.—Cement production value accounted for more than one-third of the total value of industrial minerals produced in Missouri in 1987. The values of masonry and portland cement produced increased about 28% and 3%, respectively. Production of masonry cement was unchanged from the 1986 level, but portland cement output increased about 10%. About 74% of the finished portland cement was sold to ready-mixed concrete companies. Five cement plants operated at almost 97% of rated grinding capacity and almost 100% of clinker production capacity.

Clays.—Total production and value of

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clays, excluding fuller's earth, increased almost 12% and 57%, respectively. Common clay and shale, fire clay, and fuller's earth were produced in 13 counties at 32 pits operated by 13 companies. Common clay and shale output amounted to 1,140,000 short tons, valued at $2.7 million. Fire clay production totaled 336,000 tons, an increase of about 81%; value increased nearly 130% to $7.7 million.

Lime.—Lime production increased moderately, and Missouri again ranked second of 34 producing States. Output was from three counties by three companies, two of which produced both quicklime and hydrated lime.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates. Production and value were estimated to have increased moderately in 1987.

Industrial.—Industrial sand production increased more than 20%, and value increased nearly 25%. Three companies operated three pits in Jefferson and St. Louis Counties. The largest end use, in terms of value, was in ground fillers, followed by container fabrication and flat glass.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates. Crushed stone production increased slightly over 7%, and value increased more than 8% in 1987.

Table 4 presents end-use data for crushed stone produced in the eight Missouri districts depicted in figure 1.

Table 3.—Missouri: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	326	959
Riprap and jetty stone	3,647	11,561
Filter stone	403	1,366
Coarse aggregate, graded:		
Concrete aggregate, coarse	4,085	15,572
Bituminous aggregate, coarse	2,215	8,777
Bituminous surface-treatment aggregate	1,067	4,065
Railroad ballast	1,441	3,675
Other graded coarse aggregate	75	240
Fine aggregate (-3/8 inch):		
Stone sand, concrete	417	1,731
Stone sand, bituminous mix or seal	147	551
Screenings, undesignated	1,071	4,179
Coarse and fine aggregates:		
Graded road base or subbase	7,491	25,867
Unpaved road surfacing	2,471	9,382
Crusher run or fill or waste	1,120	5,306
Other construction[2]	475	1,597
Agricultural: Agricultural limestone	1,873	6,044
Chemical and metallurgical: Cement manufacture	3,103	7,552
Special: Other miscellaneous[3]	885	3,167
Other unspecified[4]	22,597	73,231
Total[5]	54,910	184,824

[1]Includes limestone, dolomite, and granite.
[2]Includes terrazzo and exposed aggregate.
[3]Includes poultry grit and mineral food, other agricultural uses, lime manufacture, dead-burned dolomite, flux stone, chemical stone, and roofing granules.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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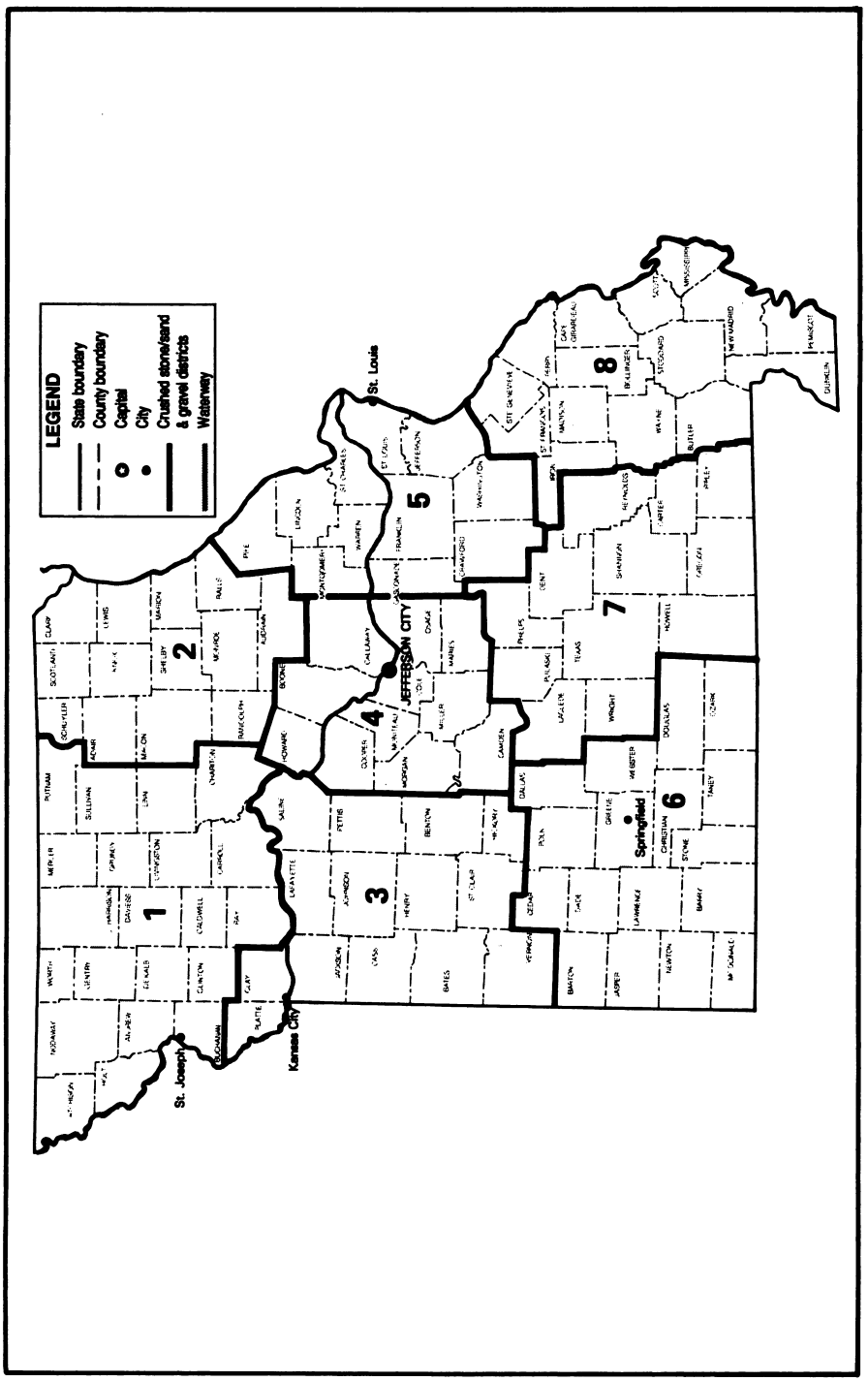

Figure 1.—Aggregate-producing districts in Missouri.

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Table 4.—Missouri: Construction sand and gravel sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	102	553	W	W	142	886	94	150
Coarse aggregate, graded[2]	372	1,932	W	W	657	4,006	615	1,831
Fine aggregate (-3/8 inch)[3]	W	W	--	--	56	190	W	12
Coarse and fine aggregates[4]	811	4,423	357	1,294	1,938	7,464	907	2,848
Other construction	547	3,015	193	763	--	--	153	148
Agricultural[5]	149	698	130	422	803	2,308	171	403
Chemical and metallurgical[6]	--	--	(7)	(7)	(7)	(7)	--	--
Special[8]	--	--	--	--	--	--	--	--
Other miscellaneous	--	--	--	--	--	--	--	--
Other unspecified[9]	768	2,446	2,392	6,468	6,392	27,723	683	2,487
Total[10]	2,749	13,067	3,072	8,947	9,987	42,576	2,623	7,879

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	293	1,057	71	250	W	W	3,612	10,777
Coarse aggregate, graded[2]	2,642	9,754	1,497	5,637	W	W	2,613	7,416
Fine aggregate (-3/8 inch)[3]	537	1,788	W	W	8	39	163	412
Coarse and fine aggregates[4]	4,775	17,084	1,108	4,108	236	887	1,016	2,703
Other construction	95	343	486	1,910	355	1,205	--	--
Agricultural[5]	84	264	275	1,029	96	367	173	572
Chemical and metallurgical[6]	(11)	(11)	(11)	(11)	--	--	(11)	(11)
Special[8]	--	--	(11)	(11)	--	--	(11)	(11)
Other miscellaneous	1,661	3,580	284	990	--	--	584	2,132
Other unspecified[9]	7,771	15,467	3,089	13,754	509	1,614	2,444	7,271
Total[10]	17,859	49,281	6,810	27,677	1,204	4,113	10,606	31,283

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous suface-treatment aggregate, railroad ballast, and coarse aggregate (graded).
[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screenings).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[5]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[6]Includes cement manufacture, lime manufacture, dead-burned dolomite, flux stone, and chemical stone for alkali works.
[7]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[8]Includes roofing granules.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.
[11]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

Other Industrial Minerals.—Perlite from out-of-State sources was expanded by Brouk Co. and Georgia-Pacific Corp. Total value of expanded perlite sold or used fell nearly 39%. International Mill Service Co. processed iron and steel slag from electric furnaces at Kansas City. Tripoli from out of State was refined into microcrystalline mild abrasives by American Tripoli Co. Brouk Co. and W. R. Grace & Co. produced exfoliated vermiculite from stock shipped from out of State. Sales or use of exfoliated vermiculite increased more than 20%, and total value increased nearly 31% in 1987.

METALS

Aluminum.—Aluminum production increased about 25%; however, total value increased only 12%, owing to an 11% decrease in the average value per metric ton. Noranda Aluminum Inc., the State's only producer, reached a significant milestone early in 1987 by producing the 2 millionth ton of aluminum at its primary reduction plant in New Madrid County. Noranda tapped its first metal at the plant in February 1971. Current annual production capacity is 204,000 metric tons.

Copper, Lead, Silver, and Zinc.—Copper, silver, and zinc were byproducts of lead operations by three companies in the Viburnum Trend of southeastern Missouri. Production dropped for all four commodities because of lower average ore grades and technical problems. Values were up, however, due to increases in metal prices. Average lead prices increased on the London Metal Exchange from 18.43 cents per pound in 1986 to 26.99 cents in 1987. Domestic producer copper cathode prices increased about 18.6 cents per pound to 82.5 cents, and U.S. High grade zinc metal prices increased to

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41.6 cents per pound, up 3.6 cents. Average silver prices quoted by Handy & Harmon for the same period increased from $5.47 to to $7.01 per troy ounce.

Copper production decreased nearly 17%, but value increased about 4% in 1987. The State ranked sixth of 11 producing States. The 1987 company annual report to stockholders by Cominco Ltd., Fluor, and Homestake indicated that total copper concentrate production for Missouri was about 47,000 short tons. Doe Run began construction of a copper flotation-and-recovery circuit at the Buick Mine and mill complex to improve production and to increase mining flexibility.

Recoverable lead production decreased about 9%, but value increased almost 48%. The State led the Nation in recoverable lead production, accounting for more than 90% of the total. According to 1987 company annual reports by ASARCO Incorporated, Cominco, Homestake, and Fluor, total lead concentrate production in Missouri was about 372,000 short tons. Doe Run produced about 244,000 tons of lead concentrates, making Doe Run the leading producer in the Nation. Early in the year, Doe Run reopened the Buick Mine, which had been idle since May 1986. The Brushy Creek Unit and the Buick smelter remained idle. Operations continued at the Herculaneum smelter.

Cominco operations at the Magmont Mine are a joint venture with Dresser Industries Inc., with each partner owning equal shares. Most of the year's production came from the Magmont-West ore body. Cominco's annual report indicated that its share of lead concentrate production in 1987 was 49,500 tons.

Asarco reported producing 29,400 tons of lead concentrates from the Sweetwater and West Fork Mines. The Sweetwater Unit began production in late December at 40% of rated capacity of 75,000 tons. Formerly known as the Milliken Mine, idle since 1983, it was acquired from Kennecott in 1986. The West Fork Unit operated at about 55% of its rated capacity of 66,000 tons. Asarco also operated a smelter at Glover, MO.

Silver production in 1987 dropped about 19%, but value increased nearly 4%. The State ranked seventh of 18 producing States and accounted for 3% of the Nation's total production. The Buick Mine was the State's leading producer and ranked 22d nationally.

Missouri continued to rank third among zinc-producing States, despite an 8% decline in output, and accounted for 16% of the Nation's production. Value increased nearly 2%. The Buick Mine was the State's leading zinc producer and ranked seventh nationally.

Iron Ore.—Pea Ridge Iron Ore Co. was the State's sole producer of iron ore. Production and value from the Nation's only underground iron mine decreased 7% and 18%, respectively.

Iron Oxide Pigments.—Pea Ridge was the only producer of both crude and finished iron oxide pigments in Missouri. One other company, Columbian Chemicals Co., produced finished pigments. Production and value of crude iron oxide pigments decreased moderately compared with 1986 levels.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.
[2]Geologist, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO.
[3]Geologist, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO (retired).
[4]Highway and Heavy Construction Magazine. June 1987, p. 36.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Noranda Aluminum Inc	New Madrid, MO 63869	Plant (smelter)	New Madrid.
Barite:			
Desoto Mining Co	Box 35 Richwoods, MO 63071	Mine and plant	Washington.
General Barite Co	119 West Clement St. De Soto, MO 63020	Mines and plant	Do.
NL Baroid, a division of NL Petroleum Services Inc.	Box 2808 St. Louis, MO 63111	do	Do.
Cement:			
Continental Cement Co	Box 71 Hannibal, MO 63401	Quarries, clay pit, plant.	Ralls.
Dundee Cement Co	Box 67 Clarksville, MO 63336	Quarry, clay pit, plant	Pike.
Lone Star Industries Inc	Box 5050 Greenwich, CT 06836	Quarry and plants	Cape Girardeau.
Missouri Portland Cement Co., a subsidiary of Cementia Holdings AG.	7711 Carondelet Ave. Clayton, MO 63105	Quarry and plant	Jackson.
River Cement Co., a subsidiary of IFI International of Italy (Instituto Finanziario Industriale S.p.A.)	Box 14545 St. Louis, MO 63178	do	Jefferson.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays:			
Dillon Clay Mining Co	Box 115 St. James, MO 65559	Pits	Crawford.
A. P. Green Refractories Co., a subsidiary of USG Corp.	1018 East Breckenridge St. Mexico, MO 65265	Pits and plants	Audrain, Crawford, Franklin, Gasconade, Osage.
Southern Clay Inc. (Lowe's Inc.)	Box 1086 Cape Girardeau, MO 63701	do	Stoddard.
Iron ore:			
Pea Ridge Iron Ore Co., a subsidiary of Fluor Corp.[1]	Route 4 Sullivan, MO 63080	Underground mine and plant.	Washington.
Iron oxide pigments (finished):			
Columbian Chemicals Co	1600 Parkwood Circle Suite 400 Atlanta, GA 30339	Plant	St. Louis.
Lead:			
ASARCO Incorporated[2]	Route 1, Box 202C Bunker, MO 63629		
Glover smelter		Smelter	Iron.
Sweetwater Unit		Underground mine and plant.	Reynolds.
West Fork Unit		do	Do.
Cominco American Incorporated[2]	Bixby, MO 65439	do	Iron.
The Doe Run Co.[2]	11885 Lackland Rd. Suite 500 St. Louis, MO 63146		
Buick		Underground mine, plant, smelter.	Do.
Casteel		Underground mine	Do.
Fletcher		Underground mine and plant.	Reynolds.
Herculaneum smelter		Smelter	Jefferson.
Viburnum Div. Mill		Plant	Iron.
Viburnum No. 28		Underground mine	Do.
Viburnum No. 29		do	Washington.
Lime:			
Ash Grove Cement Co	8900 Indian Creek Parkway Suite 600 Overland Park, KS 66225	Plant Quarries	Greene. Greene, Jackson, Polk.
Mississippi Lime Co	7 Alby St. Alton, IL 62002	Plant	Ste. Genevieve.
Resco Products of Missouri Inc., Bonne Terre Limekiln.	Box 1110 Clearfield, PA 16830	do	St. Francois.
Perlite (expanded):			
Brouk Co	1367 South Kings-highway Blvd. St. Louis, MO 63110	do	St. Louis City.
Georgia-Pacific Corp	133 Peachtree St., NE. Atlanta, GA 30303	do	Crawford.
Sand and gravel:			
Construction (1986):			
Holliday Sand & Gravel Co., a subsidiary of List & Clark Construction Co.	6811 West 63d St. Overland Park, KS 66204	Dredges and plants	Clay.
Limited Leasing Co., a subsidiary of St. Charles Sand Co.	Route 1, Box 158 Hazelwood, MO 63042	do	St. Louis and St. Louis City.
Winters Bros. Material Co	13098 Gravois Rd. St. Louis, MO 63127	Dredge and plant	St. Louis.
Industrial:			
Master Bros. Silica Sand Co., a subsidiary of Bussen Quarries Inc.	Route 1, Box 204 Pevely, MO 63070	do	Jefferson.
Unimin Corp	258 Elm St. New Canaan, CT 06840	Mine and plant	Do.
U.S. Silica Co	Box 187 Berkeley Springs, WV 25411	Dredge and plant	St. Louis.
Slag—iron and steel:			
International Mill Service Co	1818 Market St. Philadelphia, PA 19103	Plant	Jackson.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Crushed:			
Granite:			
GAF Chemicals Corp	Box 186 Annapolis, MD 63620	Quarry and plant	Iron.
Quality Aggregate Co	Box 307 Piedmont, MO 63957	do	Wayne.
Limestone-dolomite:			
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27622	Quarries and plants	Andrew, Daviess, Gentry, Harrison, Holt, Mercer, Nodaway, Worth.
Moline Consumers Co	313 16th St. Moline, IL 61265	do	Jefferson, Knox, Ralls, Ste. Genevieve.
Tower Rock Stone Co	Box 69 Columbia, IL 62236	Quarry and plant	Ste. Genevieve.
Fred Weber Inc	7929 Alabama Ave. St. Louis, MO 63111	Quarries and plants	Jefferson, St. Charles, St. Louis.
West Lake Quarry & Material Co.	13570 St. Charles Rock Rd. Bridgeton, MO 63044	do	Cape Girardeau, Jefferson, St. Louis.
Dimension:			
Granite:			
Granite Panelwall Co	Box 898 Elberton, GA 30635	Quarry and plant	St. Francois.
Missouri Red Quarry Inc	Box 516 Elberton, GA 30635	do	Iron.
Sandstone:			
Beavers Stone Co	Box 322 Camdenton, MO 65020	do	Camden.
Vermiculite (exfoliated):			
Brouk Co	1367 South Kingshighway Blvd. St. Louis, MO 63110	Plant	St. Louis City.
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Do.

[1]Also crude iron oxide pigme.
[2]Also copper, silver, and zinc.

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The Mineral Industry of Montana

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Montana Bureau of Mines and Geology for collecting information on all nonfuel minerals.

By W. L. Rice,[1] D. C. Lawson,[2] and Richard B. Berg[3]

Montana's nonfuel mineral production value rose to $368.5 million in 1987, an increase of nearly 55%. A near doubling of copper production, a significant rise in gold output, a substantial first-year production of platinum-palladium, and a nearly tripled molybdenum production were primarily responsible for a 108% increase in the State's metallic mineral production value. The largest value gains in 1987 were those for copper, gold, molybdenum, and silver.

Gold was the leading commodity in terms of value, followed by copper, silver, platinum, and portland cement. The metals—copper, gold, iron ore, lead, molybdenum, platinum, silver, and zinc—accounted for

Table 1.—Nonfuel mineral production in Montana[1]

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	279	$8,296	222	$5,882	[2]29	[2]$98
Copper (recoverable content of ores, etc.) metric tons	15,092	22,281	W	W	W	W
Gem stones	NA	400	NA	480	NA	1,302
Gold (recoverable content of ores, etc.) troy ounces	160,262	50,909	W	W	234,365	104,984
Gypsum thousand short tons	W	W	W	W	24	W
Lead (recoverable content of ores, etc.) metric tons	846	356	W	W	W	W
Sand and gravel (construction) thousand short tons	e9,000	e26,000	8,066	19,391	e6,800	e18,000
Silver (recoverable content of ores, etc.) thousand troy ounces	4,010	24,630	4,773	26,110	5,837	40,920
Stone (crushed) thousand short tons	[3]1,730	[3]5,044	e [3]2,200	e [3]6,200	1,463	3,585
Talc do.	W	W	W	W	386	12,321
Combined value of barite (1985, 1987), cement, clays (fire clay, 1987), iron ore (usable), lime, molybdenum (1986-87), peat, phosphate rock, platinum-group metals (1987), sand and gravel (industrial), stone (crushed traprock, 1985-86, and, dimension), vermiculite, zinc (1987), and values indicated by symbol W	XX	r62,166	XX	r179,870	XX	186,456
Total	XX	r200,282	XX	r237,933	XX	368,466

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

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73% of the State's nonfuel mineral value for 1987, compared with 58% in 1986 and 49% in 1985. Montana ranked 24th in the Nation in value of nonfuel mineral production in 1987, up from the 33d ranking achieved in 1986.

Table 2.—Nonfuel minerals produced in Montana in 1986, by county[1]

County	Minerals produced in order of value
Beaverhead	Sand and gravel (industrial).
Big Horn	Sand and gravel.
Broadwater	Lime, gold, silver.
Carbon	Clays, sand and gravel.
Carter	Clays.
Cascade	Sand and gravel, gold, silver.
Chouteau	Sand and gravel.
Custer	Do.
Dawson	Do.
Deer Lodge	Do.
Fergus	Sand and gravel, gysum.
Flathead	Sand and gravel, peat.
Gallatin	Cement, sand and gravel, clays.
Granite	Silver, copper, gold, lead.
Hill	Sand and gravel.
Jefferson	Gold, cement, sand and gravel, gold, silver, clays.
Judith Basin	Gypsum.
Lake	Sand and gravel.
Lewis and Clark	Do.
Liberty	Do.
Lincoln	Copper, silver, vermiculite, lead, gold, sand and gravel.
Madison	Talc, sand and gravel, gold, silver.
Meagher	Iron ore, gold.
Missoula	Sand and gravel.
Musselshell	Do.
Park	Do.
Petroleum	Do.
Phillips	Gold, silver, sand and gravel.
Pondera	Sand and gravel.
Powell	Phosphate rock, gold, sand and gravel.
Ravalli	Sand and gravel.
Richland	Lime, sand and gravel.
Rosebud	Sand and gravel.
Sanders	Do.
Sheridan	Do.
Silver Bow	Copper, molybdenum, silver, sand and gravel.
Teton	Sand and gravel.
Toole	Do.
Valley	Clays, sand and gravel.
Yellowstone	Lime, sand and gravel.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—A revival of underground metal mining at Butte came several steps closer to reality in 1987. In April, Washington Corps., the parent company of Montana Resources Inc. (MRI), sold the long-dormant Butte Hill underground mines to Montana Mining Properties (MMP), newly formed by a group of Australian and British investors. The new company, backed by $100 million raised on the London Stock Exchange, initially set to work reopening underground workings and accessing blocks of ground around the Travona and Lexington Mines. The company intends to develop surface and underground mines on ore bodies primarily valuable for silver and gold, along with lesser base metals; excess capacity at MRI's Butte Concentrator would be used to process ore prior to construction of a new mill. MMP has divided the hill into 14 claim blocks; each block will be researched and marketed for development.

Employment.—According to the Montana Department of Labor and Industry, overall mining employment, including petroleum and coal industry workers, declined to 5,700 from the 5,900 reported in 1986. Metal mining employment, however, increased to 1,700 workers, up from the 1,100 employee total for 1986. Average weekly earnings for Montana's mineral-industry workers rose slightly to $549.99 from $546.06 in 1986. Mineral-industry workers again were the highest paid group in the private nonfarm industries wage sector.

Environmental Issues.—The U.S. Environmental Protection Agency (EPA) continued studies of mining-related pollution problems in the Clark Fork River drainage. EPA initiated Superfund testing and cleanup work at several sites. It sampled soils in Butte at all localities where mining had taken place, and also sampled selected residential sites and children's play areas for heavy metal contamination. In Walkerville, the EPA contracted to have six mine waste dumps, containing about 500,000 cubic yards of material, removed from residential areas and hauled to the Alice Pit.

At the Anaconda smelter site in the town of Anaconda, Deer Lodge County, Artech Ventures tested a hydrometallurgical process to recover bismuth, copper, gold, lead, mercury, and zinc from an estimated 327,000 tons of arsenical flue dust. The processing method, the Cashman process, was developed jointly with the U.S. Bureau of Mines. Processing of the flue dust was to commence in 1988, at an initial rate of 97 tons per day. Artech awaited a decision by EPA at yearend regarding a storage site for the encapsulated arsenic, and the suitability of the closed Arbiter solvent extraction-electrowinning (SX-EW) plant for processing the material.

An EPA study released in midyear stated that wastes discharged from Asarco's East Helena lead smelter over the last 50 years have produced elevated levels of arsenic, lead, and other heavy metals in the soil, water, plants, and livestock around the Helena Valley. The study was conducted as part of the Superfund study process; EPA stated that the level of danger posed to humans would not be known until some time in 1988.

Exploration Activities.—Exploration in

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1987 was confined primarily to precious metals and talc in the western and central parts of the State. Although fewer new applications for exploration were filed, application for renewals increased, and there was a gain in the number and footage of holes drilled. An indication that exploration activity had shifted toward ore body delineation was expressed by a drop in the number of new operating plans filed with the U.S. Forest Service; 116 plans were filed in 1987, compared with 341 for 1986.

As of mid-November, about 9,600 new mining claims had been filed during 1987, for a total of about 57,200 active, unpatented mining claims in the State. The U.S. Bureau of Land Management reported that patents were granted for 75 claims, and that 12 additional applications for patent had been received. By yearend, the cumulative total of Small Miner's Exclusion Statements was 1,211, with 84 of that total issued in 1987. A total of 177 State exploration licenses were active, with 31 new licenses granted during the year; there were approximately 450 active exploration projects in Montana in 1987.

Western Energy Co. was active in several areas of the State in 1987. Company activities included exploration drilling for gold in Beaverhead County, drilling for precious metals west of Silver Star in Madison County, working on the McDonald Meadows, Seven-Up Pete, and Keep Cool gold exploration projects near Lincoln in Lewis and Clark County, and conducting a joint-venture, gold-silver project at the Tuxedo Mine northwest of Butte, Silver Bow County.

The Elkhorn District in Jefferson County was the site of intensive precious-metals exploration in 1987. Gold Fields Mining Corp. continued a large-scale drilling program and further consolidated its land position, and the Mountain West Resources Inc.-Homestake Mining Co. joint venture conducted more deep drilling on a gold-bearing pipe at the Elkhorn property.

The southeastern end of the Pioneer Mountains and the adjoining Argenta District in Beaverhead County were explored for gold by several companies. Yellowband Mines Inc. and Placer Dome U.S. Inc. conducted drilling projects, and Minex Exploration explored at the Ermont Mine near Argenta.

Noranda Exploration Inc. continued a gold exploration program at the Revenue Mine area west of Norris, and United Reef Petroleum trenched on two gold-bearing vein systems on the Alder Gulch property in Madison County.

Freeport McMoRan Gold Co. continued gold exploration in the Emery District of Powell County; CoCa Mines Inc. renewed drilling on the Hog Heaven silver-gold project southeast of Kalispell, and Santa Fe Pacific Minerals Corp. continued exploration for gold in the Sweetgrass Hills, Liberty County.

A Colorado-based company explored for gold in the Scratchgravel Hills near Helena. Gold King Mines Corp. began a gold exploration program on 12,000 acres northwest of Helena; the company reevaluated several old mine dumps and drilled targets on extensions of the Jay Gould vein system. Inspiration Mining Co. did extensive drilling on the York gold property northeast of Helena, Lewis and Clark County. Pangea Resources Ltd. drilled in the area between its Porphyry Dike and Paupers Dream gold properties.

The Utah International Inc.-Cominco American Incorporated joint venture continued drilling near White Sulphur Springs in Meagher County; the area has been explored over the past several years for sediment-hosted massive sulfide deposits.

Texas Northern Minerals Ltd. explored the Midas and Nine Mile properties near Libby and Missoula, Silver Bow County; the Crown Butte Resources-Noranda Exploration Inc. joint venture completed a 44-hole reverse-circulation-drilling program at the New World gold project near Cooke City, Park County; and Canyon Resources Corp. and Montana Talc Co. evaluated their talc holdings in the Ruby Range, Madison County.

Legislation and Government Programs.—Montana wilderness bills were introduced in both houses of Congress in 1987. The two bills, although differing in some details, each proposed about 1.3 million acres of additional wilderness for the State and proposed release to multiple use of about 4.1 million acres of roadless areas. An additional 730,000 acres were proposed to be set aside as National Recreation Areas, and for future study. Opposition by both wilderness and industry proponents was vociferous; the Montana Mining Association testified that a total of 334 patented mining claims and several highly mineralized areas would be removed from multiple use. Both bills died before yearend.

Montana received a $4 million grant in

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1987, from the Federal Office of Surface Mining, to help clean up 80 abandoned mine sites throughout the State. The grant money, issued to the Montana Department of State Lands, was spent on eight coal mine and two noncoal reclamation projects. The reclamation work closed mine portals, removed abandoned structures, improved drainage, stabilized subsidence, and extinguished burning coalbeds. Montana has received more than $35 million from the Federal Government for mine reclamation since the program started in 1981.

Montana received $28.2 million in 1987 from the U.S. Bureau of Land Management as royalties from the Mineral Leasing Act.

Mineral taxes collected by the State on nonfuel minerals, coal, oil, and natural gas amounted to $100.9 million; mineral taxes represented nearly 20% of total Montana Department of Revenue collections in 1987.

The Mining and Mineral Resources Research Institute at the Montana College of Mineral Science and Technology, Butte, received funding totaling $190,000 from the U.S. Bureau of Mines during fiscal year 1987. The institute has received a total of $2.4 million since inception of the program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Aluminum.—Columbia Falls Aluminum Co. (COFAC) operated its Flathead County reduction plant at the annual rated capacity of 180,000 short tons of metal in 1987. The Montana Legislature enacted a bill to lower the company's State property tax by $2.4 million to about $1.6 million, a level that was comparable to the property taxes paid by other aluminum smelters in the Northwestern States. COFAC had alumium tolling contracts that assured full-scale operation through 1989; in November, the company signed an extended 6-year tolling contract with Norsk Hydro Trading Co. that covers 60% of plant capacity through December 1995.

Antimony.—United States Antimony Corp. produced antimony oxide at its refinery near Thompson Falls, Sanders County; antimony sulfide concentrates were purchased on contract from China. In midyear, the company finished construction of a 10-million-pound-per-year sodium antimonate plant; the product was used as a degasser for glass in color television picture tubes and in flame retardant products.

Copper.—Reflecting the first full year of renewed production at Montana Resources Inc.'s Butte operations, Montana's 1987 copper output was nearly double that achieved in 1986. Copper production was reported from four mines in three counties, compared with output from three mines in three counties in 1986. Montana ranked fifth in the Nation in 1987 copper production.

The State's copper producers were Montana Resources in Silver Bow County, ASARCO Incorporated's silver-copper mine near Troy in Lincoln County, Black Pine Mining Co.'s Black Pine Mine near Philipsburg, and Strykers Gold's Silver King Mine, both in Granite County.

Montana Resources mined 40,000 tons of copper-molybdenum ore per day from the Continental Pit at Butte; copper concentrates were rail-shipped to Vancouver, WA, and loaded for ocean transport to smelters in the Republic of Korea and Japan. By yearend 1987, the company had recorded a profit of $1.4 million, and had paid back all of a $7.1 million loan obtained from the Montana State Board of Investments. The total economic impact of the mine to Butte and to the State, since its reopening in July 1986, had been more than $34 million.

Gold.—Montana's gold production increased by about 25% in quantity and by approximately 50% in value over that of 1986. Production was reported from 12 lode mines in 7 counties, compared with output from 7 mines in 5 counties in 1987.

In 1987, Pegasus Gold Inc. broke all production records at its Zortman-Landusky seasonal open pit, heap-leach operation in the Little Rockies, Phillips County, achieving first rank in Montana gold production for the year. According to the company's annual report, more than 9.6 million tons of ore was mined and loaded onto the leach pads, resulting in the production of 106,900 troy ounces of gold and 202,600 troy ounces of silver. A carbon adsorbtion plant was installed to increase process-plant recovery capacity, and technological advances were made to lengthen the leaching season. Although mining was confined to the warmer months, leaching was now possible for 11 months of the year, albeit at reduced levels in the winter months. At yearend, reserves totaled 32.6 million tons, grading 0.02 ounce of gold per ton. A continuing exploration program was expected to add to the reserves.

According to Placer Dome Inc.'s 1987 annual report, gold production from the Golden Sunlight Mine near Whitehall, Jef-

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ferson County, decreased slightly to 89,496 ounces from 2.4 million tons of ore, compared with 92,404 ounces of gold recovered from 2.3 million tons of ore in 1986. The decrease was the result of lower grade ore encountered when mining was shifted to upper benches in the mine's stage 2 development program. The mill feed rate was increased, and gold recovery improved to 80.4% from the 77.6% rate achieved in 1986. The first year of operation for the sand-tailing-retreatment circuit was responsible for the increased recovery; production costs were further reduced by the preaeration circuit, which decreased cyanide consumption by 20%. Underground diamond drilling delineated a downward extension of the ore body, adding substantially to proven ore reserves. Reported ore reserves at yearend were 42 million tons, grading 0.054 ounce of gold per ton; this was up from the 16.7 million tons at 0.042 ounce of gold per ton reported in 1986. The Golden Sunlight Mine was the State's second-ranked producer in 1987.

Pegasus' Montana Tunnels Mine near Wickes, Jefferson County, commenced milling ahead of schedule on March 25. The company's annual report disclosed that 1987 production from the 12,500-ton-per-day surface mine's flotation concentration operation was 31,800 ounces of gold, 529,300 ounces of silver, 8.6 million pounds of lead, and 14.4 million pounds of zinc. Lead-silver concentrates were trucked to Asarco's East Helena smelter. The Montana Tunnels ore reserves at yearend were 50.3 million tons grading 0.025 ounce of gold, 0.49 ounce of silver, 0.25% lead, and 0.65% zinc.

Near yearend, Pegasus announced plans to develop a $10 million open pit, heap-leach gold operation at the Beal deposit in German Gulch, Silver Bow County. The company planned to mine 8.7 million tons of ore over a 10-year period, with an annual recovery of between 32,000 and 35,000 ounces of gold and 25,000 ounces of silver. Projected startup was the fall of 1988, with an annual payroll of $2.1 million and a work force of up to 65 people.

The Appaloosa Joint Venture achieved 50-ton-per-day production in September at the Spotted Horse Mine in the Judith Mountains, Fergus County, and Blue Range Engineering put its 150-ton-per-day flotation mill into operation. The mill, housed in a part of the old USG Corp. gypsum mill at Heath, Fergus County, milled ore from the Gies Mine.

The underground mines on Butte Hill, at one time owned by Anaconda Minerals Co., were purchased in April by MMP from Missoula-based Washington Corps. MMP formed 15 new mining companies to develop the Hill properties by blocks or mining units. The formation of an operating company, Butte Mining PLC, with a $100 million capitalization, was announced in October; Butte Mining's stated purpose was to resume underground and surface mining, largely for precious-metals deposits. Initially, the company opened the portal of the Alice-Lexington Tunnel to access the Lexington Mine, and announced intentions of resuming mining in the Tzarina and Rainbow Blocks, near the Travona and Lexington Mines.

The Jardine Joint Venture project of Homestake Mining Co. and American Copper & Nickel Co. Inc. in Park County remained on hold during the year, awaiting a production decision. Western Energy Co., likewise, put a hold on its Chartam gold project near Winston, Broadwater County.

According to the Montana Bureau of Mines and Geology, placer gold was recovered from Grasshopper Creek near Bannock; Quartz Creek east of Superior; Sauerkraut Creek near Lincoln; Washington Gulch southeast of Avon; Browns Gulch west of Nevada City; and Indian Creek west of Townsend. Placer gold production was reported to the U.S. Bureau of Mines from three operations in Powell County, where gold was recovered from stream and bench gravels by a nonfloating washing plant and by small-scale mechanical and hand methods.

Iron Ore.—Hallet Minerals Co. produced iron ore from the Black Butte Mine near White Sulphur Springs, Meagher County. Production was at about the same level as reported in 1986; the product was used within the State in the manufacture of cement.

Lead.—Montana's lead production increased sevenfold in volume and nearly 12 times in value from the 1986 output; the State ranked fourth in the Nation in lead production in 1987. Lead was recovered as a byproduct from three base- and precious-metals mines in two counties, although most of the production came from Pegasus' new Montana Tunnels operation in Jefferson County.

Asarco's 75,000-ton-per-year-capacity lead bullion smelter at East Helena reportedly processed about 243,000 tons of concentrates in 1987, yielding just under 55,000 tons of lead bullion; this was up from the

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50,800 tons produced in 1986. The bullion also yielded 14,676,400 ounces of silver and 125,000 ounces of gold. About 30% of the concentrates reportedly came from the western States, 29% from other domestic sources, 7% from Canada, and 34% from other foreign sources, including China for the first time.

Molybdenum.—Molybdenum production nearly tripled in quantity and value from 1986. The sharp increase resulted from the first full year of production by Montana Resources' Butte copper operations, where molybdenum was recovered as a significant byproduct. Montana Resources was the State's sole molybdenum producer; concentrates were shipped to Belgium, Chile, the Netherlands, and the United Kingdom for processing.

Platinum-Palladium.—In March, the Stillwater Mining Co. (SMC) joint venture of Chevron Resources Corp., Lac Minerals Ltd., and Manville Corp. started production at the Western Hemisphere's first primary platinum-palladium concentrator near Nye, Stillwater County. The underground mine commenced operating in late 1986, and about 80,000 tons of ore had been stockpiled before mill startup. The $42 million operation, designed for an initial 500-ton-per-day (tpd) capacity, was averaging 610 tpd in July. Current plans were to increase production to 700 tpd in early 1988, and to 1,000 tpd by 1990. The expansion program, involving the enlargement of existing buildings, construction of new support facilities for the underground operation, and purchase of a $2.5 million tunnel-boring machine, will cost about $30 million. SMC's operation, which employed about 300 in 1987, was expected to have about 400 workers when the expansion program is completed.

Concentrates were shipped to Metallurgie Hoboken-Overpelt S.A., Belgium, for smelting and refining. In late summer, SMC completed a feasibility study for a small electric-furnace smelter, costing less than $10 million, to be sited near the mill.

In November, a Chevron-Manville partnership proposed opening a second platinum-palladium mine in the Stillwater Complex south of Big Timber, Sweetgrass County. The proposed operation would be similar in size to the SMC mine, would initially employ about 300 people, and would be operational in about 5 years. The companies expected to begin an 18-month study of the proposed operation in the spring of 1988.

Silver.—In response to a rebound in the price of silver, the quantity of Montana's silver production rose by 22% and the value increased by about 57% from 1986. The State produced nearly 15% of the Nation's silver and retained a third-place ranking in silver production. Output was reported from 11 mines in 7 counties, compared with production from 10 mines in 8 counties in 1986. Asarco's Troy silver-copper mine in Lincoln County was again Montana's top silver producer and the first-ranked silver-producing mine in the Nation. According to Asarco's 1987 annual report, the Troy Mine produced 4.3 million ounces of silver and 18,500 tons of copper from 3,144,000 tons of ore, compared with 4.1 million ounces of silver and 19,000 tons of copper from 3,122,000 tons of ore in 1986. Ore reserves at yearend were nearly 38 million tons grading 1.52 ounces of silver per ton and 0.75% copper.

Pegasus' Zortman-Landusky gold mine rose to be second ranking in silver production in the State.

Production at Black Pine Mining Co.'s Black Pine Mine near Philipsburg, Granite County, halted in April 1986, resumed in May. The mine was the State's third-ranked silver producer in 1987. In May, Asarco filed application with the Montana Department of State Lands to develop the Rock Creek stratabound silver-copper deposit. The proposed mine, in the Cabinet Mountains Wilderness, Sanders County, would produce more than 5 million ounces of silver annually; the 144-million-ton ore reserve, grading 1.65 ounces of silver per ton and 0.68% copper, represented a mine life of 30 years. The 10,000-ton-per-day underground mine would access the ore bodies by a 9,000-foot adit with the portal outside the wilderness boundary. Flotation concentrates would be trucked to a railhead at Noxon, and rail-shipped to a smelter. Mine development would take about 3-1/2 years; about 350 workers would be employed at the mine.

United States Borax and Chemical Corp. did additional drilling at the Rock Lake stratabound silver-copper deposit in the Cabinet Mountains Wilderness. Work on an environmental impact statement was started during 1987.

Zinc.—Zinc production was reported for the first time since 1981. Although small in comparison with that from the top four zinc-producing States, it was sufficient to rank Montana's output fifth in the Nation.

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Pegasus' Montana Tunnels gold-silver-zinc-lead mine accounted for all of the State's zinc production in 1987.

The zinc fuming plant at Asarco's East Helena lead smelter did not operate in 1987; it had been on standby status since 1982.

INDUSTRIAL MINERALS

Barite.—Mountain Minerals Co. Ltd., of Lethbridge, Ontario, Canada, purchased Montana Barite Co.'s Missoula barite mill and deposits in early 1987. Mountain Minerals mined barite from the Coloma deposit in Missoula County; the mine product was shipped to the company's Lethbridge plant for milling.

Cement.—Montana's cement production dropped 19% in quantity and by nearly 5% in value from those of 1986. In March, Hanson Trust PLC of the United Kingdom purchased Kaiser Cement Corp. In April, Kaiser's Montana City plant was sold to Ash Grove Cement West Inc. Portland cement was produced by Ash Grove Cement at Montana City, Jefferson County, and by Ideal Basic Industries Inc. at Trident, Gallatin County; Ash Grove also produced masonry cement. The bulk of cement produced was general-use, moderate-heat Types I and II gray portland cement; lesser amounts of Type III high-early-strength, Type V high sulfate resistance, and oil well cements also were produced. Portland cement produced in the State was used by ready-mix concrete companies (59%), highway contractors (12%), other contractors (11%), concrete products manufacturers (8%), miscellaneous customers (7%), and building material dealers and government agencies (3%).

Chlorite.—Cyprus Industrial Minerals Co. mined high-purity chlorite at the Golden Antler Mine near Silver Star, Madison County; the chlorite was sold for many of the same industrial applications for which talc was used. Trenching and evaluation of a newly discovered chlorite deposit, southwest of Silver Star in the Rochester District, were under way during the summer of 1987.

Clays.—Clay production in the State dropped drastically from the level reported in 1986. A cessation of bentonite production was largely responsible for an 87% decrease in quantity and a 98% drop in the value of Montana's clay production in 1987.

Common clay, produced by four companies from four pits in Gallatin and Jefferson Counties, was used in cement and pottery. Fire clay was produced from one operation in Deer Lodge County. Kanta Products mined shale from pits in Jefferson and Gallatin Counties and operated an expanded shale and construction materials plant at Three Forks.

Gem Stones.—The State ranked sixth nationally in natural gem stone production in 1987. Vortex Mining Co. at Utica, Judith Basin County, operated a sapphire-washing plant on a western extension of the Yogo sapphire dike, and Roncor Inc. produced sapphires from an operation on the main Yogo dike. Placer sapphires were produced by several small operations in the Missouri River District, Lewis and Clark County, and by an operation in the Rock Creek District, Granite County. Twinned quartz crystals and smoky quartz were produced from operations in Jefferson and Missoula Counties, respectively.

Gypsum.—The State's gypsum production decreased by nearly 79% in quantity and 73% in value. USG permanently closed the Heath wallboard plant and Shoemaker underground gypsum mine in January. The operation, which had been a mainstay of the economy in Judith Basin County for more than 60 years, had employed about 50 people. High freight rates, long distances to major markets, and high production costs for the underground mine were reasons cited for the closures.

Maronick Construction Co. Inc. mined gypsum from an open pit at Raynesford, Judith Basin County. The product was shipped to the Ash Grove Cement plant at Montana City, and to the Ideal Basic Industries cement plant at Trident.

Lime.—Lime production increased by nearly 3% but dropped slightly in value. Continental Lime Inc., Holly Sugar Corp., and The Great Western Sugar Co. produced quicklime in Broadwater, Richland, and Yellowstone Counties, respectively.

Peat.—Peat production in 1987 increased by 50% in quantity and by 55% in value. Peat produced by Martins Peat Inc. at Swan Lake, Flathead County, was sold in bulk. Farmer's Plant Aid Corp. produced peat that was dried and marketed in packaged form.

Phosphate Rock.—A 6-month closure of Cominco's Warm Springs underground phosphate mine near Garrison, Powell County, resulted in a 72% decrease in tonnage and a 71% drop in the value of Montana's phosphate production from 1986. Permanent closure, in June 1986, of the company's Kimberly, British Columbia, Canada, fertilizer plant temporarily depriv-

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ed the mine of an outlet for its product. During the latter part of 1987, the Kimberly washing and dry grinding operation was moved to the Warm Springs site, where installation was expected to be completed during 1988. The company will then produce two products: a fine-ground material grading 20% P_2O_5, which will be sold for direct application in agriculture, and a coarser product containing 31.5% P_2O_5, which will be shipped to Cominco's Trail, British Columbia, smelter for acid treatment and conversion into fertilizer.

Stauffer Chemical Co., which owns the Silver Bow elemental phosphorus plant west of Butte, was sold twice during the year. Imperial Chemical Industries of Great Britain purchased the Stauffer interests in June. In September it resold the basic chemicals division, including the Silver Bow plant, to the U.S. division of Rhône-Poulenc S.A., a French company. The Silver Bow plant produced elemental phosphorus from phosphate rock mined in Idaho and rail-shipped to the plant.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Estimated 1987 construction sand and gravel production dropped about 16% in quantity and 3% in value from 1986. Decreased activity in highway construction and maintenance contributed significantly to the decline.

Industrial.—Industrial sand and gravel production was reported by Stauffer Chemical Co. from the Maiden Rock quarry, Beaverhead County. The product was used for flux at the company's Silver Bow elemental phosphorus plant.

Stone.—Stone production is surveyed by the U.S Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

The 1987 output of crushed stone in Montana decreased by almost 34% in tonnage and 42% in value from 1985. Crushed stone production was reported from eight counties. Ideal Basic Industries, Ash Grove Cement, and the Park County Highway Department were the leading producers. Travertine building stone was produced by the Livingston Marble & Granite Works from its quarry north of Gardiner, Park County.

Table 3.—Montana: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse and fine aggregates: Other construction[2]	119	443
Chemical and metallurgical: Cement manufacture	1,032	2,527
Other miscellaneous[3]	312	616
Total	1,463	[4]3,585

[1]Includes limestone, traprock, sandstone, quartzite, and volcanic cinder and scoria.
[2]Inclues riprap and jetty stone, bituminous aggregate (coarse), graded road base or subbase, and unpaved road surfacing.
[3]Includes flux stone, sugar refining, uses reported without a breakdown by end use, and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Sulfur (Recovered).—Montana Sulphur & Chemical Co. and Farmers Union Central Exchange recovered sulfur as a byproduct from petroleum refining in Yellowstone County. The State's 1987 sulfur production increased by nearly 5% in volume, but declined slightly more than 1% in value from 1986.

Talc.—Montana retained first ranking in the Nation for the quantity and value of its talc production, although the 1987 output decreased moderately in quantity and the value dropped slightly from 1986. Production came from four open pits and one underground operation in the Ruby, Gravelly, and Greenhorn Ranges in Madison County.

Cyprus Industrial Minerals completed the first year of production from its Beaverhead Mine, a cut-and-fill underground talc mine. Cyprus also mined talc from the Yellowstone open pit, where a newly installed mechanical sorting facility increased talc recovery and reduced sorting costs. Ore from company talc operations was processed at the Three Forks mill in Gallatin

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County. Development work was done on Cyprus' MP property south of the Beaverhead Mine; the new property was scheduled for production in mid-1988.

Pfizer Inc. operated the Treasure Chest surface mine in 1987; ore was processed at the Barretts mill, near Dillon, Beaverhead County. Montana Talc Co. completed the first full year of production from the Johnny Gulch open pit south of Ennis, and operated the mill at Sappington, Gallatin County. Willow Creek Talc Co. closed its mine in the Greenhorn Range during the year; the operation subsequently was put up for sale.

Vermiculite.—Montana ranked second nationally in vermiculite production. Production decreased by 21%, and the value declined 17%. Production in 1987 was 77% of the yearly average for 1983-87; the value of production was about 84% of the yearly average for the 5-year period. W. R. Grace & Co. mined and milled vermiculite at the Rainy Creek operation near Libby, Lincoln County, and completed the patent process on a block of new mining claims that added substantially to ore reserves at the Rainy Mine.

Stansbury Mining Corp. announced plans to mine vermiculite in the Sapphire Mountains east of Hamilton, Ravalli County. The company intended to concentrate the ore at the minesite, and to truck the concentrates to a $6.5 million exfoliation plant in Butte. Startup of the operation was projected for the summer of 1988.

Robinson Insulation Co. at Great Falls, Cascade County, produced exfoliated vermiculite that was sold for block insulation, loose fill insulation, agricultural soil conditioner, concrete aggregate, horticultural applications, and fireproofing material.

[1]State Mineral Officer, Bureau of Mines, Spokane, WA.
[2]Staff field agent, Montana Bureau of Mines and Geology, Butte, MT.
[3]Geologist, Montana Bureau of Mines and Geology, Butte, MT.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Columbia Falls Aluminum Co	Columbia Falls, MT 59912	Reduction plant	Flathead.
Cement:			
Ash Grove Cement West Inc	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Plant and quarry	Jefferson.
Ideal Basic Industries Inc., Cement Div.	Box 8789 Denver, CO 80201	do	Gallatin.
Copper:			
ASARCO Incorporated	Box 868 Troy, MT 59935	Underground mine and plant.	Lincoln.
Montana Resources Inc	600 Shields Ave. Butte, MT 59701	Surface mine and plant	Silver Bow.
Gem Stones:			
Roncor Inc	2056 South Burrington Ave. Los Angeles, CA 90025	do	Judith Basin.
Vortex Mining Co	Utica, MT 59452	do	Do.
Gold:			
Golden Sunlight Mines Inc., a subsidiary of Placer U.S. Inc.	Box 678 Whitehall, MT 59759	do	Jefferson.
Pegasus Gold Inc	North 9 Post Suite 400 Spokane, WA 99201	Surface mines and leach plant.	Phillips.
		Surface mine and plant	Jefferson.
Gypsum:			
Maronick Construction Co. Inc	East Helena, MT 59635	Surface mine	Judith Basin.
Lead:			
Pegasus Gold Inc	North 9 Post Suite 400 Spokane, WA 99201	Surface mine and plant	Jefferson.
Lime:			
Continental Lime Inc	268 West 400 South Suite 201 Salt Lake City, UT 84101	Surface mine	Broadwater.
The Great Western Sugar Co	3020 State Ave. Box 30878 Billings, MT, 59107	Surface mine and plant.	Yellowstone.
Holly Sugar Corp	Box 1052 Colorado Springs, CO 80901	do	Richland.

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Table 4.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Phosphate rock:			
Cominco American Incorporated	Box 638 Garrison, MT 59731	Underground mine and plant.	Powell.
Platinum-palladium:			
Stillwater Mining Co	Star Route Box 365 Nye, MT 59061	do	Stillwater.
Silver:			
ASARCO Incorporated	Box 868 Troy, MT 59935	do	Lincoln.
Black Pine Mining Co	Box 610 Philipsburg, MT 59858	Underground mine	Granite.
Montana Resources Inc	600 Shields Ave Butte, MT 59701	Surface mine and plant	Silver Bow.
Pegasus Gold Inc	North 9 Post Suite 400 Spokane, WA 99201	do	Jefferson.
Stone:			
Crushed and broken:			
Ash Grove Cement West Inc	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Quarries	Do.
Big Horn Calcium Co	Box 22007 Billings, MT 59104	Quarry	Caribou.
Ideal Basic Industries Inc., Cement Div.	Box 8789 Denver, CO 80201	Quarries	Gallatin.
Kaiser Cement Corp., a subsidiary of Hanson Trust PLC	Montana City, MT 59602	do	Jefferson.
Park County Highway Department	Livingston, MT 59047	Quarry	Park.
Dimension:			
Livingston Marble & Granite Works	Box 851 livingston, MT 59047	Quarry and plant	Do.
Sulfur (recovered):			
Montana Sulphur & Chemical Co	Box 31118 Billings, MT 59107	Plant	Yellowstone.
Talc:			
Cyprus Industrial Minerals Co	Box 3299 7000 South Yosemite Englewood, CO 80155	Plant, surface and under ground mines.	Gallatin and Madison.
Monana Talc Co	28769 Sappington Rd. Three Forks, MT 59752	Plant and surface mine.	Do.
Pfizer Inc	Box 1147 Dillon, MT 59725	do	Beaverhead and Madison.
Vermiculite:			
W. R. Grace & Co., Zonolite Div	1114 Avenue of the Americas New York, NY 10036	do	Lincoln.
Zinc:			
Pegasus Gold Inc	North 9 Post Suite 400 Spokane, WA 99201	do	Jefferson.

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The Mineral Industry of Nebraska

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey) for collecting information on all nonfuel minerals.

By Leon E. Esparza[1] and Raymond R. Burchett[2]

Value of nonfuel mineral production in Nebraska in 1987 dropped to about $89.7 million, almost 5% below that of 1986. This marked the third consecutive year of decline. It can, in part, be attributed to the lag in the State's large farm economy. Production value did, however, post gains for five of eight commodities produced in Nebraska. The value of industrial sand posted the largest percentage increase. The value of portland cement, the State's most important nonfuel mineral in terms of dollar value, dropped as did masonry cement. Nebraska ranked 43d in the Nation for value of nonfuel mineral production.

Most of the State's nonfuel mineral production was used in construction. According to the U.S. Department of Commerce, a total of 4,902 residential units were authorized in 1987, down from 6,236 issued in 1986. Value of nonresidential construction, however, increased 7% to $264.6 million. Awards for State road contracts dropped to $159.0 million, a loss of 16%.[3] The Nebraska Department of Labor reported that mining employment dropped by 3% to 1,665 jobs.

Table 1.—Nonfuel mineral production in Nebraska[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	244	$718	221	$668	224	$721
Gem stones	NA	e10	NA	10	NA	10
Sand and gravel (construction) thousand short tons	e11,600	e28,800	9,675	23,912	e10,300	e26,300
Stone (crushed) do	4,175	19,134	e4,000	e17,900	4,316	19,461
Combined value of cement, lime, and sand and gravel (industrial)	XX	51,308	XX	51,598	XX	43,256
Total	XX	99,970	XX	94,088	XX	89,748

eEstimated. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Nebraska in 1986, by county[1]

County	Minerals produced in order of value
Antelope	Sand and gravel (construction).
Blaine	Do.
Box Butte	Do.
Brown	Do.
Buffalo	Do.
Burt	Do.
Butler	Do.
Cass	Cement, sand and gravel (construction), clays.
Cedar	Sand and gravel (construction).
Chase	Do.
Cheyenne	Do.
Clay	Do.
Colfax	Do.
Cuming	Do.
Custer	Do.
Dawes	Do.
Dawson	Do.
Deuel	Do.
Dixon	Do.
Dodge	Do.
Douglas	Sand and gravel (construction), clays.
Franklin	Sand and gravel (construction).
Furnas	Do.
Garden	Do.
Hall	Do.
Hamilton	Do.
Harlan	Do.
Hitchcock	Do.
Holt	Do.
Howard	Do.
Jefferson	Sand and gravel (construction), clays.
Kearney	Sand and gravel (construction).
Keith	Do.
Knox	Do.
Lancaster	Clays.
Lincoln	Sand and gravel (construction).
Loup	Do.
Madison	Do.
Merrick	Do.
Morrill	Lime, sand and gravel (construction).
Nance	Sand and gravel (construction).
Nemaha	Do.
Nuckolls	Cement, sand and gravel (construction).
Perkins	Sand and gravel (construction).
Phelps	Do.
Pierce	Do.
Platte	Do.
Polk	Do.
Red Willow	Do.
Saline	Do.
Sarpy	Sand and gravel (construction), clays.
Saunders	Sand and gravel (construction), sand (industrial).
Scotts Bluff	Lime, sand and gravel (construction).
Sheridan	Sand and gravel (construction).
Stanton	Do.
Thayer	Do.
Thomas	Do.
Valley	Do.
York	Do.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—During 1987, active mining operations in Nebraska included 657 sand, gravel, and silt or siltstone pits; 28 limestone quarries; 15 sandstone pits; and 7 clay or shale pits. These 707 active mining operations disturbed 980 acres and reclaimed 294 acres during the year.[4]

Legislation and Government Programs.—The Central Interstate Low Level Radioactive Waste Compact Commission chose Nebraska as the host for a proposed low-level radioactive waste disposal facility. The compact is composed of five States: Arkansas, Kansas, Louisiana, Nebraska, and Oklahoma. By order of Congress, the compact must have the site in operation by January 1, 1993.

In late December, a new mineral resource map of the State was published by the Nebraska Geological Survey. The map depicts locations of active clay, gravel, sand, sandstone and silt pits, limestone quarries, and oilfields and gasfields.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—In 1987, quantity and value of masonry and portland cement fell moderately. Both cement types were produced by the State's sole producer, Ash Grove Cement Co. Ideal Basic Industries Inc., a subsidiary of Holderbank Financiere Glaris SA, Switzerland, had been a large contributor to the State's production total. However, in 1986 production was discontinued at Ideal's only plant in the State, and the facility operated mostly as a distribution terminal in 1987. A small amount of portland and masonry cement was shipped from stocks previously produced at the plant.

Clays.—Value of clays increased 8%, but production only increased about 1%. Most of the production went into brick manufacturing, and the balance was used in portland cement mixtures. Clay was produced by four companies from five pits in five counties.

Lime.—Both quantity and value of lime sold or used increased. Western Sugar Co. shipped limestone from its quarries in Wyoming to plants in Morrill and Scotts Bluff Counties. Quicklime produced from the limestone was used in sugar refining.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1986 and estimates for 1985 and 1987. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel accounted for 29% of the State's total value of nonfuel mineral production, an increase of 4% over the 1986 percentage. Production and value increased 6% and 10%, respectively.

Industrial.—Western Sand & Gravel Co. was the State's sole producer of industrial sand. The company operated one pit in Saunders County. Production was sold for traction and sandblasting.

Stone (Crushed).—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates. In 1987, production and attendant value of crushed stone increased approximately 8% and 9%, respectively, compared with 1986 figures.

Table 3.—Nebraska: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate: Riprap and jetty stone	77	411
Coarse aggregate, graded: Concrete aggregate, coarse	1,516	6,877
Combined coarse and fine aggregates:		
Unpaved road surfacing	363	1,848
Other construction[2]	1,224	6,274
Agricultural:		
Agricultural limestone	117	527
Poultry grit and mineral food	146	1,347
Other miscellaneous[3]	873	2,179
Total	4,316	[4]19,461

[1]Includes limestone.
[2]Includes bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, screenings (undesignated), graded road base or subbase, and crusher run or fill or waste.
[3]Includes agricultural uses, cement manufacture, production reported without a breakdown by end use, and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Other Industrial Minerals.—Expanded Perlite was produced from perlite received from other States by the Zonolite Div. of W. R. Grace & Co. at its Omaha plant. Talc in crude form was received from out-of-State sources and processed by Cyprus Industrial Minerals Co. in Hall County. Processing consisted of grinding crude talc for use in ceramics, insecticides, and textiles. W. R. Grace also produced exfoliated vermiculite from ore shipped to its plant in Douglas County from a mine and mill near Libby, MT. Many small firms produced gem stones by cutting and polishing agates, chalcedony, chert, jasper, petrified wood, and quartz.

METALS

Antimonial lead, refined bismuth, and silver were processed from lead bullion by ASARCO Incorporated at its Omaha refinery. The bullion was supplied from company smelters at Glover, MO, and East Helena, MT. Defined capacity of the Omaha refin-

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ery is 156,000 short tons per year. During 1987, the refinery operated at 41% of defined capacity and processed 63,500 short tons of lead bullion.[5]

Ferret Exploration Co. of Nebraska Inc. successfully completed testing of its uranium in situ-leach pilot plant near Crow Butte, west of Chadron. In late November, Ferret applied for commercial mining permits with the U.S. Nuclear Regulatory Commission and the Nebraska Department of Environmental Control. Current ore reserve estimates indicate a 20-year mine life at a proposed production rate of 500,000 pounds of uranium oxide per year.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.
[2]Research geologist, Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey), Lincoln, NE.
[3]Highway and Heavy Construction Magazine. June 1987, p. 36.
[4]Nebraska Geological Survey, Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska—Lincoln. Nebraska Mineral Operations Review, 1987. 19 pp.
[5]ASARCO Incorporated. 1987 Annual Report. P. 13.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co	Box 25900 Overland Park, KS 66225	Quarry, clay pit, plant.	Cass.
Ideal Basic Industries Inc., a subsidiary of Holderbank Financiere Glaris SA.	Box 8789 Denver, CO 80201	Stockpile shipments.	Nuckolls.
Clays:			
Endicott Clay Products Co	Box 17 Fairbury, NE 68352	Pit and plant	Jefferson.
Yankee Hill Brick Manufacturing Co.	Route 1 Lincoln, NE 68502	do	Lancaster.
Lime:			
Western Sugar Co	Anaconda Towers Suite 1400 555 17th St. Denver, CO 80202	Plants	Morrill and Scotts Bluff.
Perlite (expanded):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Douglas.
Sand and gravel (construction) (construction, 1986):			
Central Paving Sand & Gravel Co. Inc	Box 626 Columbus, NE 68601	Pits and plants	Butler, Madison, Nance, Platte, Stanton.
Hartford Sand & Gravel Co	Box Z Valley, NE 68064	Dredges and pits	Douglas and Hall.
Lyman-Richey Sand & Gravel Corp	4315 Cuming St. Omaha, NE 68131	Pits and plants	Cass, Douglas, Platte, Saunders.
Western Sand & Gravel Co.[1]	Box 28 Ashland, NE 68003	Dredges and pits	Cass, Dodge, Saunders.
Stone (crushed):			
Fort Calhoun Stone Co	1255 South St. Blair, NE 68008	Quarries and plants.	Washington.
Kerford Limestone Co	Box 449 Weeping Water, NE 68463	do	Cass.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	do	Cass, Nemaha, Pawnee, Saunders.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Douglas.

[1]Also industrial sand in Saunders County.

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The Mineral Industry of Nevada

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Nevada Bureau of Mines and Geology for collecting information on all nonfuel minerals.

By Fred V. Carrillo[1] and Larry J. Garside[2]

The value of Nevada's nonfuel mineral production in 1987 was $1.5 billion, an increase of $470 million or 48% from that recorded in 1986. Nevada ranked third nationally in the value of its nonfuel mineral production.

Nevada led the Nation in the production of barite, gold, mercury, and silver and was the sole producer of mined magnesite. Gold was the leading commodity produced in terms of value, accounting for $1.2 billion or more than 80% of the total nonfuel mineral value produced in the State.

Table 1.—Nonfuel mineral production in Nevada[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite thousand short tons	590	$10,904	184	$3,005	308	$4,778
Clays do.	[2]80	[2]3,776	[2]10	[2]584	65	2,468
Gem stones	NA	[e]1,300	NA	213	NA	280
Gold (recoverable content of ores, etc.) troy ounces	1,276,114	405,369	[r]2,098,980	[r]772,909	2,679,470	1,200,269
Gypsum thousand short tons	1,207	8,942	1,236	8,221	W	W
Lead (recoverable content of ores, etc.) metric tons	([3])	([3])	--	--	--	--
Mercury 76-pound flasks	16,530	W	W	W	W	W
Perlite short tons	W	W	4	122	W	W
Sand and gravel:						
Construction thousand short tons	[e]9,500	[e]24,880	12,197	35,692	[e]10,600	[e]30,700
Industrial do.	479	W	518	W	578	W
Silver (recoverable content of ores, etc.) thousand troy ounces	4,947	30,383	6,409	35,056	12,190	85,451
Stone (crushed) thousand short tons	1,334	6,218	[e]1,500	[e]7,000	[4]1,264	[4]5,700
Combined value of cement (portland), clays (fuller's earth and kaolin, 1985-86), copper (1985-86), diatomite, fluorspar, iron ore (usable, 1985-86), lime, lithium minerals, magnesite, molybdenum (1985), salt, stone (crushed dolomite, 1987), and values indicated by symbol W	XX	139,201	XX	114,529	XX	117,168
Total	XX	630,973	XX	[r]977,350	XX	1,446,814

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Less than 1/2 unit.

[4]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Nevada in 1986, by county[1]

County	Minerals produced in order of value
Carson City	Sand and gravel.
Churchill	Barite, diatomite, salt, sand and gravel, silver, gold.
Clark	Lime, sand (industrial), gypsum.
Douglas	Sand and gravel, gold, silver.
Elko	Gold, sand and gravel, barite, mercury.
Esmeralda	Lithium, silver, gold, diatomite, clays.
Eureka	Gold, silver, mercury.
Humboldt	Gold, mercury, silver, sand and gravel, clays.
Lander	Gold, silver, barite, copper, sand and gravel.
Lincoln	Perlite, sand and gravel.
Lyon	Cement, sand and gravel, gold, gypsum, diatomite, silver.
Mineral	Gold, silver, mercury, sand and gravel.
Nye	Gold, sand and gravel, silver, clays, magnesite, iron, fluorspar, mercury, barite.
Pershing	Diatomite, gold, silver, gypsum, iron ore.
Storey	Diatomite, sand and gravel.
Washoe	Sand and gravel, gold, clays.
White Pine	Gold, sand and gravel, silver.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—Construction and expansion projects were under way at most major gold facilities in the State, and new mining operations were begun at 12 open pit disseminated gold mines. Nevada remained the leading gold-producing State; new exploration offices continued to open in Reno. The number of new mining claims filed with the U.S. Bureau of Land Management (BLM) increased 91% over the number filed in 1986.

Nevada also became the Nation's leading silver-producing State in 1987; output was nearly double that of 1986. Increased production by two large open pit, heap-leach silver operations, and more byproduct silver from the State's gold operations accounted for the changes.

The State's major mercury mine, Placer Dome U.S. Inc.'s McDermitt Mine in Humboldt County, was closed in January because of declining mercury use and prices. Reduced levels of barite mining continued as foreign imports and depressed demand from the oil industry kept prices low. No copper, molybdenum, or tungsten production was reported in 1987.

Employment.—The Nevada mining industry employed an annual average of 8,234 workers during 1987, according to the Nevada Employment Security Department, 7,036 of which were employed in metal mining.

Statistics collected by the Nevada Division of Mine Inspection, using a different method of computation, reported 10,315 mineral-industry workers from 411 active operations in 1987. The largest number of employees were in precious metals operations, followed by the sand and gravel industry.

Legislative and Government Programs.—The Nevada State legislature established a new Division of Abandoned Mine Lands in the Department of Minerals. The Divison had the authority to search out hazardous mine openings and to identify their degree of hazard to the public. The program was funded by an assessment of 50 cents upon each active mining claim in the State. A total of 57,366 new claims were recorded by BLM in Nevada during fiscal year 1987, which brought the total claims recorded in the State under the Federal Land Policy Act to 435,464. Nevada BLM offices reported 3,381 active notices and plans for hard-rock mining operations titled under title 43, Code of Federal Regulations subpart 3809 (Hardrock Surface Management Regulations).

In addition to the abandoned mine-land tax, Nevada gold mine operations prepaid $10 million in taxes on the net proceeds of their sales in response to Nevada Assembly Bill 872, designed to help reduce the State's budget deficit for 1987. The Nevada Department of Minerals estimated that the mining industry paid more than $40 million in taxes and fees during the year.

The Nevada Bureau of Mines and Geology published three bulletins, "Geology of Elko County," "Gypsum Deposits in Nevada," and "Surficial Geology, Hydrology, and Late Quaternary Tectonics of the IXL Canyon Area."

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REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Gold.—Nevada ranked first in the Nation in the amount and value of gold produced in 1987, accounting for 54% of the total amount produced in the United States. Production increased for the eighth consecutive year to 2,679,470 troy ounces valued at $1.2 billion.

Increasing gold production made Nevada's precious metals industry a major contributor to the State's economy and particularly important to the rural areas. Exploration activity continued throughout the State with major projects in nearly every county.

More than 12 Nevada gold mines were reported to have begun production in 1987. Significant new producers included: Freeport-McMoRan Gold Co.'s Big Springs Mine in Elko County, Fischer-Watt Gold Co. and Horizon Gold Shares Inc.'s Tuscarora Mine in Esmeralda County, Atlas Gold Mining Inc.'s Gold Bar Mine in Eureka County, Gold Fields Mining Corp.'s Chimney Creek Mine in Humboldt County, Hycroft Resources & Development Corp.'s Lewis Mine in Humboldt County, Canyon Resources Corp. and Nevex Gold Co.'s Haywood-Santiago Mine in Lyon County, Nevada Goldfields Corp.'s Aurora Mine in Mineral County, and Echo Bay Mines Inc.'s Illipah Mine in White Pine County.

Construction and expansion projects were under way at most major gold facilities in the State. The Nation's largest gold producer in 1987, Newmont Gold Co. (NGC), processing newly mined and stockpiled ore, produced 589,000 ounces of gold from its Carlin area mines. During 1987, NGC began a new $400 million capital investment program to substantially increase production at its Carlin gold properties in Eureka County.

Echo Bay began construction in September of a planned $140 million expansion program at its Round Mountain gold operation. The expanded facilities, which will process 35,000 tons of ore per day, are scheduled to begin operation in September 1988. Round Mountain produced nearly 191,000 ounces in 1987 from its large heap leaching operation. Echo Bay also began construction of a new mill in Lander County to process ore from its McCoy and Cove deposits.

AMAX Inc. initiated a $14 million expansion to increase gold production by 40%, to about 200,000 ounces per year, at its Sleeper open pit mine in Humboldt County. Included in the expansion are an additional open pit and a large increase in heap-leaching capacity. Battle Mountain Gold Co. combined production from its Fortitude Mine with that of a satellite ore body developed at its new Surprise open pit in August to reach a combined 1987 yearly production of about 257,000 ounces. Exploration activity increased through the State with major projects reported in Churchill, Clark, Elko, Eureka, Humboldt, Lander, Nye, and White Pine Counties. Exploration of deep-seated gold deposits, 1,000 feet or more below the surface, began at American Barrick Resources Corp.'s Goldstrike property and Carlin Mining Co.'s Deep Post deposit in Eureka County. Deep drilling indicated major deep-seated, high-grade gold-bearing-sulfide deposits may underlie Nevada's oxidized, low-grade disseminated gold deposits presently being mined.

Mercury.—Nevada was the principal source of primary mercury production in the United States, despite the closure of Placer Dome's (formerly Placer U.S. Inc.) McDermitt Mine in January. The Humboldt County mine had been the leading U.S. producer and had operated for 11 consecutive years.

Nevada's 1987 output was nearly all by-product mercury from six gold-producing mines in Elko, Humboldt, Lander, and Nye Counties. FMC Gold's Paradise Peak gold mine near Gabbs was the Nation's largest mercury producer in 1987. Additional by-product mercury from gold operations was reported from the Alligator Ridge Mine, Amselco Minerals Inc.; the Borealis Mine, Echo Bay Minerals Co.; the Carlin Mine, NGC; the Jerritt Canyon Mine, Freeport-McMoRan; and the Pinson Mine, Pinson Mining Co.

Silver.—Nevada became the Nation's leading silver-producing State in 1987, reporting production of 12.2 million troy ounces, up 90% from that of 1986. The large rise was attributed to the increasing by-product silver from Nevada's burgeoning gold mining industry and the first year of full production at Coeur d'Alene Mines Corp.'s Rochester Mine. Value more than

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doubled to $85,451,000, aided by an average price of $7.01 per ounce for 1987, which reversed the declining price trend of the previous 4 years.

Two open pit, heap leach operations were the State's largest producers. Nerco Minerals Co.'s Candeleria Mine in Mineral County announced pouring of its 10 millionth ounce of silver in June. Coeur d'Alene Mines Corp.'s Rochester Mine reported production of 4 million ounces of silver and 27,000 ounces of gold during 1987.

Development of significant silver reserves were also reported from the Crofoot and Lewis Mines in Humboldt County, the Cove Deposit in Lander County, the Rawhide Mine in Mineral County, and the Sleeper Mine in Humboldt County. Santa Fe Pacific Mining Inc. and Pacific Coast Mines, a subsidiary of United States Borax & Chemical Corp., began development, in July, of a new open pit silver mine in Pershing County. Sunshine Mining Co.'s Silver Peak silver and gold operations in Esmeralda County were suspended in March.

INDUSTRIAL MINERALS

Barite.—Nevada continued to be the leading State in the production of primary barite, with production increasing about 67% over that of 1986, to 308,000 short tons, although it was far below the 1980 high of about 2 million tons. The largest producers were M-I Drilling Fluids Co., NL Baroid Inc., and Milpark Drilling Fluids Co. from mines in Lander and Nye Counties. Additional production was reported from four mines in Churchill, Lander, and Nye Counties.

Cement.—The Centex Corp. plant at Fernley was the sole producer of cement in Nevada during 1987. Finished portland cement from the plant was used primarily in building materials, concrete products, ready-mix contracting, and highway construction. Las Vegas Cement Co. Inc. began construction on a cement plant at Logandale in Clark County. Plans were announced to utilize locally mined limestone and clay for initial production of 600 tons per day at the new plant.

Diatomite.—Although production decreased slightly, Nevada continued to be the second-largest diatomite-producing State in 1987. Most of the diatomite produced was used for filtration purposes, with additional usage as insulation and fillers. Eagle-Picher Industries Inc. was the State's largest producer from properties in Lyon, Pershing, and Storey Counties.

Fluorspar.—Nevada ranked second in the Nation in fluorspar production in 1987. Production was solely from the Daisy Mine of J. Irving Crowell, Jr., and Son, near Beatty in Nye County. Both production and value dropped slightly from 1986 levels.

Gypsum.—Nevada ranked sixth among the States in the production of crude gypsum and fifth in the production of calcined gypsum. Crude gypsum was mined in Clark, Lyon, and Pershing Counties, and calcined gypsum was produced in Clark and Pershing Counties.

Pacific Coast Building Products Inc. and USG Corp. were the largest producers. The Genstar Gypsum Products Co.'s Blue Diamond plant, southwest of Las Vegas, was purchased by James Hardie Industries Ltd., an Australian company. Production was also reported at the Art Wilson Co.'s Adams Mine in Lyon County.

Lithium Compounds.—Foote Minerals Co.'s Silver Peak operation in Esmeralda County was the State's sole producer of lithium compounds. Lithium carbonate was produced by solar evaporation and chemical processing of lithium-rich brines pumped from beneath the Clayton Valley Lake.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains only estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Nevada's construction sand and gravel production was estimated to decrease 13% to 10,600,000 short tons in 1987.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates. before yearend. Nevada produced 1,264 million short tons of crushed stone sold or used by producers in the State, valued at $5.7 million. Output decreased 8% from that of 1985, the last year a full survey of crushed stone producers was conducted. Limestone, the principal crushed stone product in the State, was used in cement manufacture, lime manufacture and agricultural uses.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the two Nevada districts depicted in figure 1.

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[1]State Mineral Officer, Bureau of Mines, Reno, NV.
[2]Acting State Geologist, Nevada Bureau of Mines and Geology, Reno, NV.

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Table 3.—Nevada: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate, graded: Concrete aggregate, coarse	14	80
Coarse and fine aggregates:		
Unpaved road surfacing	32	48
Terrazzo and exposed aggregate	12	12
Special:		
Other miscellaneous[2]	730	3,576
Other unspecified[3]	476	1,983
Total	1,264	[4]5,700

[1]Includes limestone, granite, marble, volcanic cinder and scoria, and miscellaneous stone; dolomite data withheld to avoid disclosing company proprietary data.
[2]Includes other agricultural uses, cement manufacture, and lime manufacture.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Table 4.—Nevada: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Coarse aggregate, graded[1]	14	80	--	--
Coarse and fine aggregates[2]	33	49	12	12
Agricultural[3]	W	W	--	--
Chemical and metallurgical[4]	W	W	W	W
Special[5]	W	W	--	--
Other miscellaneous	486	2,506	125	557
Other unspecified[6]	98	490	496	2,005
Total	631	3,125	633	2,574

W Withheld to avoid disclosing individual company proprietary data; included with "Other miscellaneous."
[1]Includes concrete aggregate (coarse).
[2]Includes unpaved road surfacing and terrazzo and exposed aggregate.
[3]Includes other agricultural uses.
[4]Includes cement manufacture and lime manufacture.
[5]Includes other fillers or extenders.
[6]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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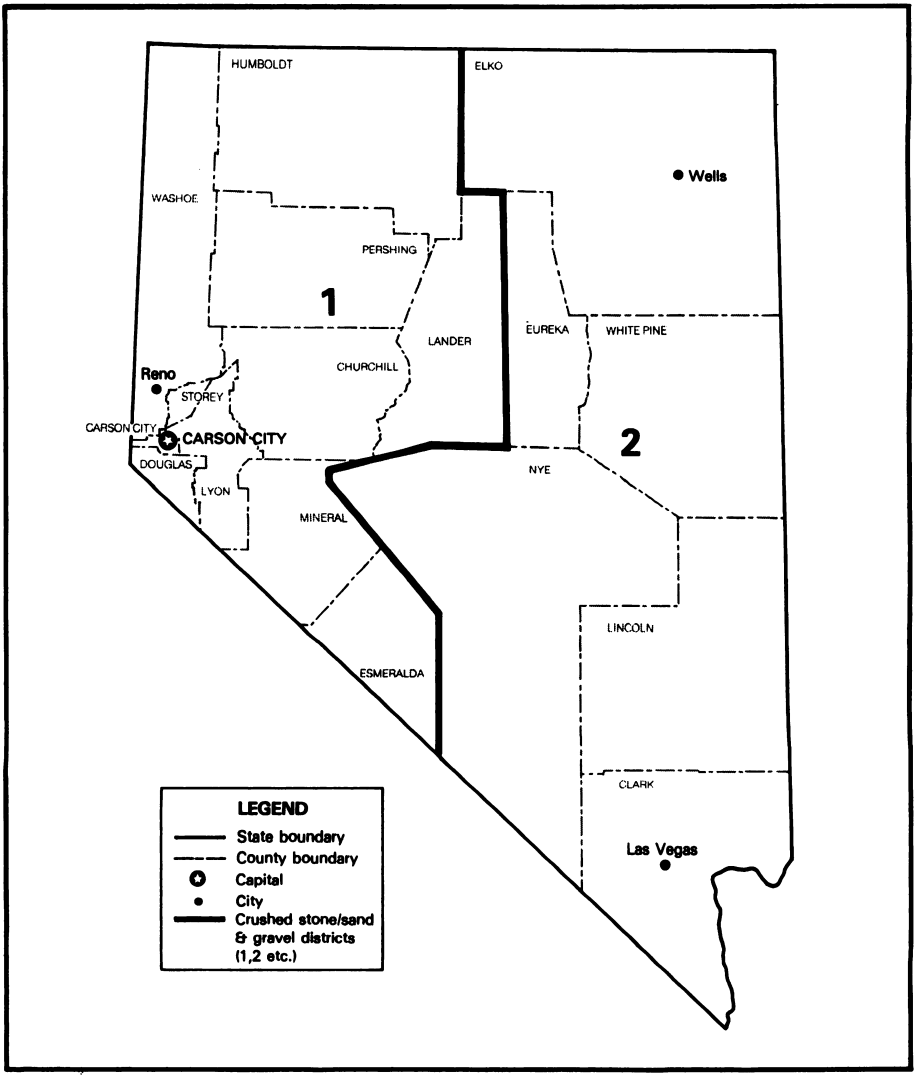

Figure 1.—Aggregate-producing districts of Nevada.

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Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
Milpark Drilling Fluids Co	Box 277 Battle Mountain, NV 89820	Surface mine and mill	Lander.
NL Baroid Inc	Box 414 Battle Mountain, NV 89820	do	Elko.
Cement:			
Centex Corp., Nevada Cement Co	Box 895 Fernley, NV 89408	Plant	Lyon.
Clays:			
Industrial Mineral Ventures Inc	1800 East Sahara Ave. Suite 107 Las Vegas, NV 89104	Surface mine and mill	Nye.
Diatomite:			
Eagle-Picher Industries Inc., Minerals Div.	Box 12130 Reno, NV 89510	Surface mine and plants.	Lyon, Pershing, Storey.
Grefco Inc., Dicolite Div	Box 288 Mina, NV 89422	Surface mine and plant	Esmeralda.
Fluorspar:			
J. Irving Crowell, Jr., and Son	Box 96 Beatty, NV 89003	Underground mine	Nye.
Gold:			
Battle Mountain Gold Co	Box 1627 Battle Mountain, NV 89820	Surface mine and mill	Lander.
Freeport-McMoRan Gold Co., Joint Venture	Mountain City Star Route Elko, NV 89801	do	Elko.
Newmont Gold Co., a subsidiary of Newmont Mining Corp.	Box 979 Carlin, NV 89822	Surface mine, mill, refinery.	Eureka.
Gypsum:			
James Hardie Gypsum Inc	HRC 89033, Box 2900 Las Vegas, NV 89104	Surface mine and plant	Clark.
Pacific Coast Building Products Inc	Box 405 37851 Cherry St. Newark, CA 94560	do	Do.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do	Pershing.
Lime:			
Chemstar Inc	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	do	Clark.
Lithium compounds:			
Foote Mineral Co	301 Lindenwood Dr. Suite 301 Malvern, PA 19395	Dry lake brines and plant.	Esmeralda.
Magnesite:			
Basic Inc	845 Hanna Bldg. Cleveland, OH 44115	Surface mine and mill	Nye.
Mercury:			
FMC Corp	Box 1237 Hawthorne, NV 89415	Surface mine and plant	Do.
Placer Dome U.S. Inc., Joint Venture	Box 497 McDermitt, NV 89421	Surface mine and mill	Humboldt.
Perlite (expanded):			
USG Corp	Empire, NV 89405	Plant	Washoe.
Salt:			
Leslie Salt Co., Huck Salt Co	895 Harrigan Rd. Fallon, NV 89406	Solar evaporation plant.	Churchill.
Sand and gravel (construction):			
ARC Materials Corp., WMK Transit	Box 14697 Las Vegas, NV 89114	Pits and mills	Clark.
Eagle Valley Construction Co	5894 Sheep Dr. Carson City, NV 89701	Pits and mill	Carson City, Douglas, Lyon, Storey.
Granite Construction Co	Box 2087 Sparks, NV 89432	do	Washoe.
Robert L. Helms Construction Co	Drawer 608 Sparks, NV 89432-0608	do	Lander and Washoe.
Las Vegas Building Materials Inc	Box 530 Las Vegas, NV 89125	Pit	Clark.
Las Vegas Paving Corp	1770 South Industrial Rd. Las Vegas, NV 89102	Pit	Do.
Paiute Pit Aggregates Inc	Box 159 Wadsworth, NV 89442	Pit and mill	Washoe.
Silver:			
Coeur-Rochester Inc	Box 1057 Lovelock, NV 89419	Surface mine and plant.	Pershing.
FMC Corp	Box 1237 Hawthorne, NV 89415	do	Nye.
NERCO Minerals Co	Box 1246 Hawthorne, NV 89415	do	Mineral.
Stone:			
Centex Corp., Nevada Cement Co	Box 840 Fernley, NV 89408	Quarry	Lyon.
Chemstar Inc	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	Quarries	Clark.
Harney Rock & Paving Inc	Box 800 Hines, OR 97738	Quarry	Elko.

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The Mineral Industry of New Hampshire

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Environmental Services for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production in New Hampshire in 1987 was $54.7 million, a $16.1 million increase over that of 1986. Construction sand and gravel and crushed and dimension stone accounted for more than 99% of the State's total mineral value. Common clay and gem stones accounted for the remaining value. Gypsum imported into the State was calcined and made into wallboard at one plant in Portsmouth, Rockingham County.

During the past several years, aggregate producers in the State have been busy because of a surge in industrial and commercial construction that created a backlog of aggregate orders. Construction in the southern part of the State was especially strong, largely because of a migration of industry from Massachusetts. Because of increasing population growth in the Nashua area, major highway and road construction projects that were in the planning stage were expected to be put out for bidding in early 1988.[2]

Table 1.—Nonfuel mineral production in New Hampshire[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	W	NA	W	NA	$310
Sand and gravel (construction) thousand short tons	e6,300	e$19,800	8,418	$26,089	e9,100	e33,300
Stone:						
Crushed do.	1,612	6,434	e1,800	e5,900	2,479	10,386
Dimension do.	80	6,625	e82	e6,451	67	10,684
Combined value of other industrial minerals and values indicated by symbol W	XX	134	XX	137	XX	(3)
Total	XX	32,993	XX	38,577	XX	354,680

eEstimated. NA Not available. Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Value excluded to avoid disclosing company proprietary data.
[3]Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

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Table 2.—Nonfuel minerals produced in New Hampshire in 1986, by county[1]

County	Minerals produced in order of value
Belknap	Sand and gravel (construction).
Carroll	Do.
Cheshire	Do.
Coos	Do.
Grafton	Do.
Hillsborough	Do.
Merrimack	Do.
Rockingham	Do.
Strafford	Sand and gravel (construction), clays.
Sullivan	Sand and gravel (construction).
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—In November, the State supreme court unanimously reversed the State Department of Resources and Economic Development's (DRED) denial of a mining permit for a 310-acre tract of land owned by Coastal Materials Corp. in Raymond. In October 1986, DRED referred the matter to the Office of the Attorney General, who ruled that the request for the mining permit came under a law that gave local town planners jurisdiction to issue permits and regulate mining. In the recent decision, the supreme court ruled that the State, not the town, had jurisdiction in the matter.

In April, the U.S. Geological Survey (USGS) began a ground water study of the Pemigewasset River watershed that focused on sand and gravel acquifers. The Pemigewasset project was the seventh in a series of 14 that will cover the entire State. The USGS teams measured the surface dimensions of sand and gravel deposits and took core samples to identify and measure the extent of sand and gravel deposits. The collected data will be fed into a computer in order to sketch a picture of the reservoirs that lie between the surface and the bedrock.

The USGS, together with the New Hampshire Office of State Geologist, began a 5-year inventory of the State's peat resources. The study will also focus on the uranium content of the peat, primarily because of public concerns about the health aspects of radon gas and uranium.

A study released by the Center for Clean Air Policy, a Washington, DC-based research center, recommended construction of a 540-mile, 1,000-megavolt power line from Ohio and West Virginia to New England. Constructing the power line would have the dual goal of reducing power costs in the Northeastern United States and preserving midwestern coal-mining jobs. The study, proposed by the Governors of New Hampshire and West Virginia stated that the power line could save New Englanders at least $2 billion over 3 decades and preserve as many as 1,000 coal-mining jobs in the Midwest. Under the plan, New England would pay for the line and transfer equipment, install flue-gas desulfuration equipment at the powerplants, and build 1,200 megavolt of replacement capacity in West Virginia in the year 2000.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Clays.—Kane Gonic Brick Corp., the State's only producer, mined common clay at a pit in Gonic, Strafford County. The clay was used to manufacture face brick and was marketed primarily in the Boston, MA, area.

Gypsum.—National Gypsum Co. operated a wallboard manufacturing plant at Portsmouth, Rockingham County. The crude gypsum was shipped from the company's subsidiary in Canada, through the Port of Portsmouth. The plant was one of only two gypsum wallboard plants in New England.

In anticipation of an increase in construction material demand, Domar Inc., a Canadian-based company, proposed to build a new $30 million, 11.5-acre gypsum wallboard plant in Newington. The new plant would be able to produce 280,000 short tons of gypsum wallboard annually and bring 85 new jobs to the area. Crude gypsum for the plant would be imported from either Spain or Nova Scotia.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Based on these estimates, output and value of construction sand and gravel increased 9% and 28%, respectively. Approximately 40 companies operated 57 pits in the State. Sand and gravel was produced in all of the State's counties. Leading counties, in decreasing order of output, were Hills-

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borough, Merrimack, Belknap, and Carroll. Main uses were for concrete aggregate, road base and coverings, and asphaltic concrete aggregates.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone was the State's third-leading commodity produced. It accounted for nearly one-fifth of the State's total mineral value. Crushed stone production totaled 2.5 million tons valued at $10.4 million, a 38% increase in output and a 76% increase in value compared with 1986 estimates. Both traprock and granite were produced by 9 companies at 10 quarries in 5 counties. Leading counties in decreasing order of output were Merrimack, Hillsborough, Grafton, Cheshire, and Rockingham. Main uses were for bituminous aggregate, road surfacing, road base, and fill.

Table 3.—New Hampshire: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	2	17
Fine aggregate (-3/8 inch): Stone sand, bituminous mix or seal	40	419
Coarse and fine aggregates: Other construction[2]	1,182	4,904
Other unspecified[3]	1,255	5,045
Total	2,479	[4]10,386

[1]Includes raprock and granite.
[2]Includes filter stone, concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, graded road base or subbase, and crusher run or fill or waste.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Dimension.—New Hampshire ranked fourth of 35 States that produced dimension stone in 1987. Only dimension granite was mined by five companies at five operations in Coos, Hillsborough, and Merrimack Counties. Primary uses were for curbing, rough blocks, and monumental stone.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]Rock Products. Aggregates: 1988 Pegged To Be "Iffy" Year. V. 90, No. 12, Dec. 1987, p. 45.

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Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Kane-Gonic Brick Corp	Gonic, NH 03867	Pit	Strafford.
Gypsum (calcined):			
National Gypsum Co	4100 First International Bldg. Dallas, TX 75270	Plant	Rockingham.
Sand and gravel (1986):			
Alvin J. Coleman & Sons Inc	Route 16 Conway, NH 03818	Pit	Carroll.
Nashua Sand & Gravel Co	Route 130 Nashua, NH 03060	Pit	Hillsborough.
Plourde Sand & Gravel Co. Inc	Suncock, NH 03275	Pit and plant	Merrimack.
Torromeo Trucking Co	33 Old Ferry Rd. Methuen, MA 01844	Pit	Rockingham.
A. Whitcomb Inc.[1]	Lancaster Rd. Gorham, NH 03581	Pits	Belknap, Carroll, Cheshire, Coos, Grafton.
F. W. Whitcomb Construction Corp.[1]	Box 429 Bellows Falls, VT 05101	Pit	Cheshire.
Stone:			
Crushed:			
Continental Paving Inc	150 Lowell Rd. Hudson, NH 03051	Quarry	Hillsborough.
Lebanon Crushed Stone Co	Plainfield Rd. West Lebanon, NH 03784	do	Grafton.
Manchester Sand, Gravel, & Cement Co.	150 Causeway St. Boston, MA 02114	do	Merrimack.
Pike Indutries Inc	Route 3, R.F.D. 2 Box 91 Tilton, NH 03276	do	Do.
F. W. Whitcomb Construction Corp.	Box 429 Bellows Falls, VT 05101	do	Cheshire.
Dimension:			
Leo Belisle Granite Co	315 Hackett Hill Rd. Hooksett, NH 03106	do	Merrimack
Kitledge Granite Corp	Armory Rd. Milford, NH 03055	do	Hillsborough.
Maine-New Hampshire Granite Corp.	Box 135, Groton Rd. West Chelmsford, MA 01863	do	Do.
Rock of Ages Corp	Box 482 Barre, VT 05641	do	Coos.
J. Swenson Granite Co	North State St. Concord, NH 03301	do	Merrimack.

[1]Also crushed stone.

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The Mineral Industry of New Jersey

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Division of Water Resources, New Jersey Department of Environmental Protection, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production in 1987 was $214 million, a $28 million increase over that of 1986. The 1987 increase took place despite the closing of the State's last remaining metal (zinc) mine in 1986. The combined value of crushed stone and construction sand and gravel, the State's two leading mineral commodities, accounted for more than four-fifths of the value of mineral production. Other commodities produced included clays, gem stones, greensand, industrial sand, and peat. Mineral commodities processed or manufactured, but not included in the State's total in table 1, included aluminum, copper, ferroalloys, graphite, gypsum, iodine, iron oxide pigments, perlite, quartz crystal, steel, sulfur, talc, and vermiculite.

Table 1.—Nonfuel mineral production in New Jersey[1]

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	130	$2,050	133	$2,066	[2]6	[2]$140
Gem stones	NA	[e]1	NA	3	NA	3
Peat ---------- thousand short tons	W	311	W	542	32	614
Sand and gravel:						
Construction ---------- do	[e]10,600	[e]36,700	13,999	53,746	[e]15,200	[e]61,200
Industrial ---------- do	2,820	31,119	2,341	29,878	2,112	27,812
Stone (crushed) ---------- do	15,692	94,339	[e]15,300	[e]95,400	[3]17,576	[3]111,961
Combined value of other industrial minerals	XX	13,056	XX	4,613	XX	12,444
Total	XX	177,576	XX	186,248	XX	214,224

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes common clays; value included with "Combined value" data.

[3]Excludes crushed limestone; value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in New Jersey in 1986, by county[1]

County	Minerals produced in order of value
Atlantic	Sand (industrial).
Bergen	Sand and gravel.
Burlington	Do.
Camden	Do.
Cape May	Peat.
Cumberland	Sand (industrial), clays.
Gloucester	Greensand, sand (industrial).
Middlesex	Sand (industrial).
Monmouth	Sand and gravel.
Morris	Do.
Ocean	Sand (industrial).
Passaic	Sand and gravel.
Salem	Do.
Somerset	Clays.
Sussex	Sand and gravel, zinc, peat.
Warren	Sand and gravel, peat.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—In the past 5 years, both residential and nonresidential construction activity in the State continued to out perform the national average and remained at record-high levels. According to F. W. Dodge Corp., contracts for nonresidential building projects in New Jersey increased by 15.6% in 1987 to a new high of $3.5 billion, following a 17.8% increase in 1986. Heavy engineering contracts were little changed at close to $1.3 billion. Homebuilding awards dropped 13.2% to approximately $4 billion. The drop in homebuilding slightly more than offset the increase in nonresidential building, with the result that total contract awards edged downward by 1.4% from their record pace of 1986.[3] Since demand for construction aggregates (sand and gravel, crushed stone, and clays) closely paralleled construction activity, producers of these commodities continued to benefit from the unprecedented building boom in the State. Increases in output and value were reported for all three of these commodities over that of 1986. Although cement is not produced in New Jersey, consumption of portland cement for construction from out-of-State sources remained relatively unchanged at 1.9 million short tons in 1987.

In the advanced-materials sector, Dynamit Nobel Chemicals Inc., Rockleigh, developed a yttria-stabilized zirconium oxide powder with exceptionally low silica content and ultrafine particle size for use in high-performance ceramics. Rhône-Poulenc Inc., Monmouth Junction, announced plans to provide ready-to-use copper-alkaline rare-earth oxides as raw materials for high-temperature superconductors. During the year, the company also acquired a 41% interest in the Spanish technical ceramics producer, Ceramicas Tenaces, maker of advanced ceramics for the aerospace and automtive industries.

Legislation and Government Programs.—In April, New Jersey became the first State in the Nation to mandate a statewide recycling program. The Mandatory Source Recycling Act of 1987 required that all 567 municipalities in the State recycle most of their refuse including cans, bottles, and scrap metal. The act substantially revised and expanded the existing Voluntary State Recycling Plan by requiring counties to adopt district recycling plans and requiring municipalities to adopt ordinances that implement the plans. Counties would run the programs and the State would have overall supervision. Under this mandatory statewide recycling program, the State expects to be self-sufficient in managing its solid waste by 1992.

Chapter 333, signed in December, was designated the Regional Low-Level Radioactive Waste Disposal Facility Siting Act. The Act created a mechanism for the siting of a regional low-level radioactive waste disposal facility. It also created a low-level radioactive waste disposal facility siting board and a low-level radioactive waste advisory committee.

Preliminary results of the first statewide scientific study for the presence of indoor radon from naturally occurring uranium in the bedrock indicated that one-third of the nearly 6,000 homes tested exceeded maximum acceptable levels. The areas within the higher concentrations represented all of Sussex, Warren, and Hunterdon Counties and portions of Bergen, Burlington, Mercer, Middlesex, Monmouth, Morris, Passaic, and Somerset Counties. After the radon program was initiated in September 1986, the State received more than 50,000 calls on a toll-free Radon Information Line and sent out more than 20,000 informational packets on the subject.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Clays.—Common clay was mined at one operation in Somerset County and fire clay was produced by one company in Cumberland County. Common clay was used primarily to manufacture common face brick; fire clay was used to produce refractory products.

In September, the Hamilton Township Zoning Board blocked JPN Earth Hauling Inc.'s plans to mine a clay deposit in the township. In December 1986, JPN had applied for a permit to mine the 100-acre tract, claiming preexisting mining rights. The company contended that it had been mining the property since the 1950's and had never abandoned the tract. The township had passed an ordinance in 1979 restricting mining; it claimed that JPN had not mined the property since the ordinance was enacted. JPN was expected to appeal the decision.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

For the last several years, construction sand and gravel has been the second leading mineral commodity produced in terms of value. In 1987, it accounted for 29% of the State's total mineral value. Construction sand and gravel was produced by nearly 60 companies at 75 pits in 15 of the State's 21 counties and was used mainly for concrete aggregates, asphaltic concrete aggregates, fill, and road base and coverings.

Restrictive zoning, increased land values, environmental regulations, and building on or near deposit sites have seriously limited or prevented resource development in the State. As a result, land-based sand and gravel deposits are scarce, especially in the Greater New York Metropolitan Area (GNYMA). Recognizing the shortage existed, McCormack Aggregates, South Amboy, has dredged the entrance to New York City's harbor since 1985. In 1987, this dredging produced between 1.6 and 1.9 million cubic yards of material, which represented the majority of the concrete sand sold in the GNYMA.

Late in the year, Blue Circle Industries PLC, United Kingdom, acquired Raia Industries Inc., an aggregate and ready-mixed concrete producer in New Jersey for $35 million. Raia Industries had extensive aggregate reserves and produced about 1 million short tons of aggregate per year. The company also produced more than 700,000 cubic yards of ready mix annually from eight locations in the State.

Industrial.—Nationally, New Jersey ranked fourth in industrial sand production in 1987. Nine companies operated 17 pits in 7 counties and produced 2.1 million short tons valued at $27.9 million. Principal uses for industrial sand were glass products, mold and core, and sandblasting.

Early in the year, New Jersey Silica Sand Co. shut down its plant and dredging operations in Maurice River Township, Cumberland County. The company cited poor sales to foundries (the primary end users) and glass plants. About 20 workers were laid off as a result of the closing.

Pennsylvania Glass Sand Corp. changed its name to U.S. Silica Co. after AT&T sold the company to Pacific Coast Resources. U.S. Silica announced plans to expand its Dragston area operation and to open a new area it had not planned to mine until 1989.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed stone, the State's leading mineral commodity, accounted for slightly more than one-half of the State's total mineral value. Production was 17.6 million tons valued at nearly $112 million, a 15% increase in output and 17% increase in value compared with 1986 estimates. Major uses were for concrete aggregate, road base and coverings, and bituminous aggregate.

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Table 3.—New Jersey: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	90	W
Riprap and jetty stone	638	4,062
Coarse aggregate, graded:		
Concrete aggregate, coarse	696	4,576
Bituminous aggregate, coarse	1,301	8,849
Bituminous surface-treatment aggregate	399	3,265
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	56	425
Screening, undesignated	111	962
Coarse and fine aggregates:		
Graded road base and subbase	1,346	8,314
Other construction[2]	3,682	27,235
Special:		
Asphalt fillers or extenders	W	130
Other unspecified[3]	9,256	54,133
Total	[4]17,576	111,951

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes granite and traprock; limestone withheld to avoid disclosing company proprietary data.
[2]Includes other fine aggregate, stone sand (concrete), crusher run or fill or waste, a minor amount used in asphalt fillers, and data indicated by symbol W.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Other Industrial Minerals.—The Inversand Co., a subsidiary of Hungerford & Terry Inc., hydraulically mined greensand marl near Clayton. Inversand was one of two companies that mined greensand in the United States and accounted for the majority of the Nation's total. The greensand was processed and sold mainly as a filtration medium to remove soluble iron and manganese from well water. Five companies mined peat in 1987—four in Sussex County and one in Warren County. Most of the output was used for general soil improvement and as an ingredient in potting soil. Mineral Recoveries Inc. recovered zircon and lecontite from tailings piles at Lakehurst. The company purchased the former ASARCO Incorporated titanium plant in 1986 and made modifications in the flotation system, dryers, and shakers to recover the minerals.

MANUFACTURED AND PROCESSED MINERALS

In addition to the commodities mined and listed in table 1, a number of processed or manufactured mineral commodities were also produced in New Jersey.

Gypsum, imported from Nova Scotia, Canada, was calcined by the National Gypsum Co., Burlington County, and by Domtar Gypsum, Camden County. The calcined gypsum was used primarily in manufacturing wallboard. Crude iodine was shipped into New Jersey by six companies to manufacture various iodine-containing compounds. The compounds were used as laboratory reagents and in sanitation, pharmaceuticals, and specialty organic and inorganic compounds. Rowan Industries Inc., Monmouth County, used cultured quartz crystal primarily in electronic applications. Crude perlite from out-of-State sources was expanded by The Schundler Co., Edison, and used for roof insulation, plaster aggregate, insulation and masonry, and as a soil conditioner. Elemental sulfur was recovered as a byproduct at two petroleum refineries in the State. The sulfur was used in the manufacture of sulfuric acid, fertilizers, plastics, and other products. Crude talc was shipped in and processed by Cyprus Industrial Minerals Co., South Plainfield. Crude vermiculite was exfoliated by W. R. Grace & Co., Construction Products Div., Trenton, and by Schundler in Edison. Principal uses were for fireproofing, loose fill, block insulation, and horticultural agents.

[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA.
[2]New Jersey Department of Labor, Division of Planning and Research. New Jersey Economic Indicators, Mar. 4, 1988, p. 4.

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Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
The Morie Co. Inc[1]	1201 North High St. Millville, NJ 08322	Pit	Cumberland.
New Jersey Shale Brick & Tile Corp	Box 490 Somerville, NJ 08876	Pit	Somerset.
Greensand:			
Inversand Co., a subsidiary of Hungerford & Terry Inc.	Box 45 Clayton, NJ 08312	Pit	Gloucester.
Gypsum (calcined):			
Domtar Inc	1101 South Front St. Camden, NJ 08103	Plant	Camden.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	do	Burlington.
Iron oxide pigments (finished):			
American Minerals Inc	Box 677 Camden, NJ 08101	do	Camden.
Columbian Chemicals Co	1600 Parkwood Circle Suite 400 Atlanta, GA 30339	do	Middlesex.
Peat:			
Glacial Soils Laboratory	346 Grand Ave. R.D. 7 Owens Rd. Box 534 Sussex, NJ 07461	Bog	Sussex.
Hyponex Corp	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bog	Do.
Kelsey Humus Co. and Partac Peat Co	Kelsey Park Great Meadows, NJ 07838	Bog	Warren.
Netcong Natural Products	Box 573AA, Pleasant Run Rd. Flemington, NJ 08822	Bog	Sussex.
Stan's Soils	R.D. 2, Box 129 Sussex, NJ 07461	Bog	Do.
Perlite (expanded):			
The Schundler Co.[1]	Box 251 Metuchen, NJ 08840	Plant	Middlesex.
Sand and gravel (1986):			
Construction:			
Ralph Clayton & Sons	Box 928 Lakewood, NJ 08701	Pit	Ocean.
The Morie Co. Inc	1201 North High St. Millville, NJ 08332	Pits	Cape Atlantic, May, Cumberland.
NJ Pulverizing Co.[2]	115 Hickory Lane Bayville, NJ 08721	Dredge	Middlesex.
Tuckahoe Sand & Gravel	Box 248 Tuckahoe, NJ 08250	do	Cape May.
Industrial:			
Unimin Corp., Dividing Creek Plant	258 Elm St. New Canaan, CT 06840	Pit	Do.
U.S. Silica Co	Box 458 Newport, NJ 08345	Pit	Cumberland.
Whitehead Bros. Co	Box 259, River Rd. Leesburg, NJ 08327	Pits	Do.
Stone:			
Granite (crushed and broken):			
Mount Hope Rock Products Inc	625 Mount Hope Rd. Wharton, NJ 07885	Quarry	Morris.
Riverdale Quarry Co	125 Hamburg Turnpike Riverdale, NJ 07457	do	Do.
Tri-County Asphalt Corp	Route 15, Box 561, R.D. 3 Hopatcong, NJ 07843	do	Sussex.
Traprock (basalt, crushed):			
Little Ferry Asphalt Corp	650 Valley Rd. 9 Bergen Turnpike Clifton, NJ 07643	do	Passaic.
Millington Quarry Inc	Box 407 Millington, NJ 07946	do	Somerset.
Stavola Construction Materials Inc	Box 482 Red Bank, NJ 07701	do	Do.
Trap Rock Industries Inc	Box 419 Kingston, NJ 08528	Quarries	Hunterdon, Mercer, Somerset.
Sulfur (recovered):			
Exxon Co. U.S.A	Box 23 Linden, NJ 07036	Refinery	Union.
Mobil Oil Corp	Paulsboro, NJ 08066	do	Gloucester.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Mercer.

[1]Also industrial sand.
[2]Also exfoliated vermiculite.

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The Mineral Industry of New Mexico

This has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New Mexico Bureau of Mines and Mineral Resources for collecting information on all nonfuel minerals.

By Lorraine B. Burgin[1] and Robert W. Eveleth[2]

The value of nonfuel mineral production in New Mexico increased from $612 million in 1986 to $738 million in 1987. Metals represented nearly two-thirds of the total value of the State's nonfuel mineral production, with copper being the principal contributor. Higher copper prices in 1987 significantly raised the value of copper output; however, most metals, including copper, declined in quantity of production.

The total value of industrial minerals output increased substantially with the gain in shipments of potassium salts and the rise in production of sand and gravel. Declines in quantity and value were posted for portland cement, clay, gypsum, and pumice; perlite also weakened in value but gained in quantity.

Nationally, New Mexico ranked 12th in total value of nonfuel mineral production, 1st in value of perlite and potassium salts, 2d in copper and mica, and 3d in pumice.

Table 1.—Nonfuel mineral production in New Mexico[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	60	$161	60	$170	51	$141
Gem stones	NA	e200	NA	200	NA	200
Gold (recoverable content of ores, etc.) troy ounces	45,045	14,309	39,856	14,677	W	W
Gypsum thousand short tons	350	1,570	W	W	W	W
Lead (recoverable content of ores, etc.) metric tons	W	W	10	5	W	W
Perlite thousand short tons	430	14,896	433	13,727	437	13,611
Potassium salts thousand metric tons	1,120	156,000	987	r132,900	1,323	174,200
Pumice thousand short tons	152	1,114	255	2,370	87	991
Sand and gravel (construction) do.	e8,400	e22,800	8,471	25,862	e8,600	e31,000
Stone:						
Crushed do.	3,641	15,232	e3,900	e15,300	4,503	15,919
Dimension do.	20	277	e22	e378	22	626
Combined value of cement, copper, helium (Grade-A), iron ore (usable, 1986-87), mica (scrap), molybdenum, pyrites (1987), salt, silver, and values indicated by symbol W	XX	430,705	XX	406,586	XX	500,987
Total	XX	657,264	XX	r612,175	XX	737,675

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in New Mexico in 1986, by county[1]

County	Minerals produced in order of value
Bernalillo	Cement, sand and gravel, clays.
Catron	Sand and gravel (construction).
Chaves	Do.
Cibola	Do.
Colfax	Do.
De Baca	Do.
Dona Ana	Sand and gravel (construction), clays.
Eddy	Potassium salts, salt, sand and gravel (construction).
Grant	Copper, silver, gold, molybdenum, sand and gravel (construction).
Hidalgo	Sand and gravel (construction), clays.
Lea	Sand and gravel (construction), salt.
Lincoln	Sand and gravel (construction), iron ore.
Luna	Sand and gravel (construction), clays.
McKinley	Sand and gravel (construction).
Nora	Do.
Otero	Do.
Quay	Do.
Rio Arriba	Pumice, sand and gravel (construction).
Roosevelt	Sand and gravel (construction).
Sandoval	Sand and gravel (construction), gypsum, pumice.
San Juan	Sand and gravel (construction), helium, clays.
San Miguel	Sand and gravel (construction).
Santa Fe	Gold, pumice, sand and gravel (construction), gypsum, silver.
Sierra	Silver, gold, sand and gravel (construction), copper, lead.
Socorro	Perlite, sand and gravel (construction).
Taos	Perlite, molybdenum, mica (scrap), sand and gravel (construction).
Torrance	Sand and gravel (construction).
Union	Do.
Valencia	Perlite, sand and gravel (construction).
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Development.—Factors contributing to the substantial increase in the value of New Mexico's nonfuel production included higher copper prices, recovery of precious metals at the Santa Rita operation of Chino Mines Co., and the gain in potash prices and output after the U.S. Department of Commerce set preliminary dumping margins on potash imports from Canada.

Copper continued to represent the most significant value in the State's nonfuel mineral production. The rapid rise in the price of the metal from a low of $0.64 to a high of $1.51 was attributed to the sizable drawdown of copper inventories and resulting tight market supply. Contributing also to the importance of copper production was the recovery of its byproduct metals—gold, molybdenum, and silver. Silver production rose in quantity and value when, for the first time in years, precious metals were reported recovered from the Santa Rita open pit copper operation. Although gold output declined when the State's leading producer closed permanently, recovery of the metal at Santa Rita and higher gold prices sustained throughout the year brought an increase in the value of gold production. Molybdenum production continued to decline because markets for the product failed to improve. Only one large-scale copper operation recovered molybdenum concentrate; the State's only primary producer remained on standby and one uranium facility idled its molybdenum circuit. Uranium output increased in 1987, however, because of higher ore grades and better recovery from mine waters.

The Carlsbad potash industry improved when Canadian producers agreed to sell their potassium salts product at a fair market value, thus improving the competitive position of New Mexico potash.

The slump in commercial building and residential construction contributed to the decline in the production of such industrial minerals as portland cement, clays, gypsum, and pumice. Increases in construction sand and gravel and crushed stone output may be attributed, in part, to public sector activities such as street, highway, airport, and other transportation-related construction.

Legislation and Government Programs.—The 1987 1st session of the 38th

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legislature passed and the Governor signed several bills related to mining. House bill 318, effective July 1, 1987, created the Energy, Minerals, and Natural Resources Department and merged the Energy and Minerals Department into the new agency. The department also will enforce and administer laws and regulations related to mine safety, coal surface mine reclamation, and abandoned mine lands reclamation. House bill 105 amended the State's Hazardous Waste Act and empowered the Environmental Improvement Board to adopt regulations, no more stringent than Federal regulations, for managing hazardous waste and underground storage tanks. House bill 95, effective April 1, 1988, required employers to provide employees information on any hazardous chemicals used in their place of employment.

The U.S. Bureau of Mines has assessed the mineral values of U.S. Bureau of Land Management (BLM) lands proposed for inclusion in the National Wilderness Preservation System since 1979. In 1987, the Bureau of Mines published open file reports on five wilderness study areas: Organ Mountains, Dona Ana County; Brokeoff Mountain, Otero County; Lonesome Ridge and a part of Devil's Den, Eddy County; Big Hatchet Mountains and Cowboy Springs, Hidalgo County; and Manzano, Torrance County.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Copper.—Although New Mexico's copper output weakened in quantity, the value of production increased nearly 24% as the average producer-copper cathode price increased from $0.66 per pound in 1986 to approximately $0.82 in 1987. Phelps Dodge Corp. became the principal copper producer in the State when the company acquired Kennecott's two-thirds ownership of Chino Mines on January 1. The Phelps Dodge Tyrone Mine led production, followed by Chino Mines' Santa Rita Mine, both near Silver City, Grant County. A comparatively small amount of copper was obtained from the Pinos Altos joint venture, near Silver City; The Goldfield Corp.'s St. Cloud Mine, Sierra County; and Sierra Corp.'s Rattlesnake Mine, Sierra County.

According to the Phelps Dodge 1987 10K Annual Report to the U.S. Securities and Exchange Commission, the Tyrone operation mined 15,563,666 metric tons with an average mill-level grade of 0.88% copper; copper recovered from concentrates and precipitates totaled 103,419 metric tons. In addition, copper production at the company's consolidated subsidiary, the Burro Chief Copper Co.'s solvent extraction-electrowinning (SX-EW) plant at Tyrone, reached 35,743 metric tons. As of December 31, 1987, the company estimated Tyrone ore reserves of 97,160,000 metric tons of 0.79% copper. Concentrate production was expected to end at Tyrone in the early 1990's. During 1987, a $1 million project was begun on the less labor-intensive SX-EW plant at Tyrone to expand its annual capacity from 41,000 tons of cathode copper to about 50,000 tons.

At the Chino Mines operation, Phelps Dodge reported mining 14,156,000 metric tons of ore (the combined total of Phelps Dodge 66-2/3% and Mistubishi 33-1/3% general partnership shares) with an average mill-level grade of 0.81% copper per ton. The copper recovered from concentrates and precipitates totaled 111,000 metric tons. Phelps Dodge estimated both partners' ore reserves totaled 318 million metric tons of 0.71% copper, as of December 31, 1987.

After Phelps Dodge assumed control of the Santa Rita Mine, several programs to reduce costs and increase productivity were introduced. Chief among them was a $55 million program to construct a new SX-EW plant with a yearly capacity of 41,000 metric tons. Burro Chief Copper, the Phelps Dodge and Brown & Root Inc. joint venture, was appointed prime construction contractor and would operate the plant when completed in late 1988. It was expected that the additional copper capacity would qualify Chino Mines as the largest producer in the State. Modifications costing $14 million to refurbish and upgrade the Hurley Inco flash furnace smelter were completed during the year. The Hurley smelter was rated at 25 million pounds of anode copper per month.

In the second quarter, Cyprus Minerals Co. acquired mining leases for the Pinos Altos copper, zinc, and silver prospect from Boliden Minerals Inc., a subsidiary of the Swedish Boliden Group. The Goldfield Corp. 1987 annual report stated that on September 23, its St. Cloud Mining Co. entered a

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50-50 joint-venture agreement with Cyprus Metals Co., a subsidiary of Cyprus Minerals, to develop, mine, and mill certain ore bodies at the Pinos Altos project near Silver City. Production of concentrate commenced on November 10. St. Cloud expected annual output from the ore bodies to yield more than 90,000 metric tons at an average grade per ton of 5.2% copper, 7.46 troy ounces of silver, and 0.017 ounce of gold.

Gold.—New Mexico gold production declined in quantity and value after the Ortiz Mine, the State's major gold producer, ceased production. Gold Fields Mining Corp, a subsidiary of Consolidated Gold Fields PLC, London, United Kingdom, shipped its last bullion cleanup from the Ortiz heap-leach operation in January. Reclamation work began and included planting trees, leveling areas, conditioning soils, and monitoring wells. In 7 years of operation, the company reported producing about 250,000 troy ounces of gold.

Leading producers of gold were the Phelps Dodge Chino Mines and Tyrone operations, where the metal was recovered as a byproduct of copper production. Other output was obtained from The Goldfield Corp.'s St. Cloud Mining operation and Sierra Corp.'s Rattlesnake Mine in Sierra County; Cyprus Minerals' Pinos Altos Mine in Grant County; Westar Corp.'s Banner Mine in Hidalgo County; and Summit Minerals Inc.'s East Camp and Summit Mountain Mines in Grant County.

Westar Resources Inc., a subsidiary of Westar Corp., Las Vegas, NV, in a joint venture with Federal Resources Corp., continued developing property near Lordsburg, Hidalgo County. Originally an underground copper mine with precious-metals values, the new project was being planned as an open pit, heap-leach gold-and-silver operation. Leach pads were loaded in September, and after a 90-day leach cycle the first bullion was expected to be poured in early 1988. The company estimated annual production of 14,500 ounces of gold and 240,000 ounces of silver with costs of approximately $250 per ounce. In October, Westar announced an agreement to acquire Federal Resources 33% interest in the project and all of Federal's Lordsburg properties, including the Banner Mine and mill, for $1.95 million plus a royalty based on the price of gold.

Molybdenum.—Of seven States shipping molybdenum concentrates, New Mexico ranked sixth. Molybdenum production declined and shipments fell about 41% in quantity and nearly 34% in value because of continued slack demand and depressed prices. The average Metals Week dealer price of molybdic oxide was $3.01 per pound of contained molybdenum, compared with $3.11 in 1986. Chino Mines, New Mexico's only producer, shipped molybdenum concentrate recovered as a byproduct of copper production. The State's only producer of primary molybdenum, Molycorp Inc., a subsidiary of Unocal Corp., continued to maintain its underground Questa Mine on standby. Officials stated reopening of the mine, shut down in 1986, would depend on improved market conditions and BLM approval of a new tailings pond proposed for construction on Guadalupe Mountain. Union members voted in March to accept a new 3-year contract including a 28% reduction in wages and benefits. With more than 600 employees before layoffs of 500 in 1986, Molycorp was a major Taos County employer. By yearend 1987, shutdown of the Questa operation brought the county unemployment rate to 22%, compared with 8% statewide.[3]

Silver.—Silver production rose about 15% in quantity and nearly 48% in value, reflecting an increase in the average price from $5.47 per troy ounce in 1986 to $7.01 in 1987. The Tyrone Mine continued as the State's leading silver producer, followed by Chino Mines. Both recovered the metal as a byproduct of copper production. Silver output was also obtained from the East Camp, Pinos Altos, Rattlesnake, St. Cloud, and Summit Mountain Mines.

Since 1985, The Goldfield Corp. had reported its St. Cloud Mine and mill as a discontinued operation; however, in the second quarter of 1987, mine operations were restarted to provide siliceous converter flux for ASARCO Incorporated's El Paso, TX, smelter. According to The Goldfield Corp. 1987 annual report, the mine produced 18,202 short tons of ore. After deducting milling losses and smelter deductions, the metal content of concentrates and ore sold was 7,927 pounds of copper, 85,864 ounces of silver, and 898 ounces of gold. The company also sold 31,273 short tons of mill tailings directly to copper smelters for use as flash furnace flux.

Other Metals.—The small amount of lead produced declined; however, its value increased slightly because the average price of lead rose from $0.22 per pound in 1986 to $0.36 in 1987. Two underground operations,

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the St. Cloud silver mine and the Cyprus Pinos Altos copper mine, recovered minor amounts of lead as a byproduct.

New Mexico produced approximately 18% of the Nation's uranium output in 1987. Four mining companies recovered 1,166 short tons of U_3O_8, an increase of about 26%. The average sale price for New Mexico uranium was reported to be $22.18 per pound, compared with $19.74 in 1986.[4] About 312 workers were directly employed at the 12 active uranium mines and 2 operating mills. Producers included: Chevron Resources Co.'s Mount Taylor Mine, Cibola County; Homestake Mining Co.'s Section 23 and 25 Mines, and Quivera Mining Co.'s Ambrosia Lake properties, McKinley County; and Ray Williams Enos Johnson Mine, Sanostee, San Juan County. Chevron Resources' underground mine, with a rated ore capacity of 650 short tons per day, was credited with almost one-half of New Mexico's production. Late in the year, Chevron ceased shipping ore to a company-owned concentrator in Texas and began shipping to the Homestake mill in Cibola County. All other uranium was recovered from concentrated ores or from mine water recovery systems. Vanadium was not recovered in 1987, and Quivira Mining shut down its byproduct molybdenum circuit as the market failed to improve.

INDUSTRIAL MINERALS

Cement.—Production of finished portland cement declined and the quantity and value of sales decreased as the average cement price slipped. The output of masonry cement increased and although sales dipped their value rose as the unit price gained substantially.

Ideal Basic Industries Inc., the State's only cement operation, continued to produce portland and masonry cement at its two-kiln dry process Tijeras plant near Albuquerque. In 1987, Ideal Basic was two-thirds owned by Holdernam Inc., a wholly owned subsidiary of "Holderbank" Finançiere Glaris Ltd. of Switzerland, the world's largest cement producer. The Ideal Basic 1987 annual report revealed the company had achieved substantial savings in 1983 by selling equipment at its Tijeras plant for $53 million and then leasing it back for 20 years.

Clays.—Total clay production decreased in quantity and value as the market price of clays slipped from $2.83 per short ton in 1986 to $2.77 in 1987. Common clay and shale output, used principally for face brick, turned down 13%. Output of fire clay, required by smelters for plugging and tapping furnaces, also declined.

Gypsum.—Crude gypsum production continued to slump in quantity and value as the average value per short ton dropped to $3.72, compared with $5.10 in 1984. Calcined gypsum production also decreased in quantity and value. Gypsum was mined in Sandoval County by Centex American Gypsum Co. at the White Mesa Mine near San Ysidro, and by Ernst Teeter Trucking Inc. at the San Felipe Mine. Centex American's ore was trucked to its plant in Albuquerque for calcining and manufacturing wallboard. A new wallboard plant, announced by Centex American in 1986, was still in the planning stage. Western Gypsum Co. mined and calcined gypsum for wallboard at Rosario, Santa Fe County, until it ceased operations in the summer.

Mica.—Scrap and flake (crude) mica production increased about 9% in quantity and nearly 12% in value. Mineral Industrial Commodities of America Inc., New Mexico's only mica producer, obtained scrap mica at its Tajo Mine, Taos County, and operated a mill in Rio Arriba County. Of seven States producing scrap and flake mica, New Mexico ranked second in value of output.

Perlite.—New Mexico accounted for 82% of the crude perlite ore mined in the United States. Although output remained essentially the same, its value dipped. The State's producers were Grefco Inc., Manville Products Corp., and Silbrico Corp., all operating at No Agua Mountain near Tres Piedras, Taos County; Grefco near Socorro, Socorro County; and United States Gypsum Co., a subsidiary of USG Corp, near Grants, Cibola County. Processed ores were expanded primarily for construction-related products such as plaster, concrete aggregate, and insulation board. Other applications included filter aids and soil conditioners.

Potash.—Leading the Nation, New Mexico accounted for 90% of the domestic output of potassium salts. The State's total potassium salts production increased more than 8%, while sales increased about 34% in quantity and about 31% in value. The gain in shipments was attributed to a marked rise in demand for domestic potash and the increase in the average price. The average annual price for the three grades of muriate rose from $81.88 per ton in 1986 to $94.36 in 1987.

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Potash producers near Carlsbad included AMAX Inc.'s AMAX Potash Corp. (formerly AMAX Chemical Co.); IMC Fertilizer Inc. of International Minerals & Chemical Corp. (IMC); Lundberg Industries Ltd. (formerly owned by Ideal Basic and, earlier, by Potash Corp. of America); New Mexico Potash Corp., owned by Cedar Chemical Inc., a subsidiary of Fermenta AB of Sweden; and Western Ag-Minerals Co., controlled by Rayrock Resources Ltd. of Canada. The Mississippi Chemical Corp. operation and the National Potash Co. mine, acquired by Mississippi Chemical in 1985, remained closed as they had been since 1983 and 1982, respectively. All producers except Western Ag-Minerals mined sylvinite ore for the output of muriate of potash; Western Ag-Minerals and IMC mined langbeinite ore, which was beneficiated to yield a sulfate of potash-magnesia. AMAX Potash reported its limited reserves were expected to be depleted in 1989.

On February 10, Lundberg Industries and New Mexico Potash petitioned the International Trade Commission (ITC), Washington, DC, to impose antidumping duties on Canadian potash imported into the United States. In March, based on a preliminary determination, the ITC found evidence that U.S. potash producers were being injured because Canadian producers were dumping potash on the U.S. market at prices up to 43% less than their average cost of production. As a result, in August, the International Trade Administration of the U.S. Department of Commerce issued a preliminary finding that Canadian potash was, or was likely to be, sold in the United States at less than fair value. The agency also determined the dumping margins of each Canadian producer. The possibility of higher prices and the threat of antidumping measures on Canadian potash by spring 1988 increased sales of domestic potash during the latter part of the year.

Indicative of its financial and legal difficulties, Lundberg Industries operated intermittently in 1987. It entered bankruptcy proceedings in June, and in September, the court appointed a trustee to oversee the property.

BLM extended the royalty rate adjustment for all Federal potassium salts leases in New Mexico for an additional 2 years. The restructured rate would be 2% of the gross value of output at the point of shipment to market. Previously the rate was a sliding-scale formula based on grade.

Pumice.—Of seven States mining pumice, New Mexico ranked second, with more than 22% of the Nation's output. Production and sales plummeted as the market for concrete aggregate dropped; however, sales for abrasives and building block rose substantially. Abrasives were increasingly used in the manufacturing process for designer jeans. The average total value per ton sold increased from $9.30 in 1986 to $11.38 in 1987.

Producers included the General Pumice Corp.'s Cullen Mine near Espanola, Rio Arriba County, and mill in Santa Fe County; the Utility Block Co.'s Esquire 5-9 Mine near Ponderosa, Sandoval County; the American Pumice Co.'s mill near Santa Fe, Santa Fe County; and the Copar Pumice Co. Inc.'s mine near Los Alamos and mill near Pojoaque, Santa Fe County.

Salt.—Salt production increased nearly 19%, and sales rose 20% in quantity and more than 17% in value. In Eddy County, New Mexico Salt & Mineral Corp. harvested salt from potash tailings and United Salt Corp. dredged the material from a salt lake and an old tailings pond. In Lea County, Unichem International Co. Inc. pumped water into a salt formation at the Pioneer Water Station to produce a brine used in oil well drilling; Williams Brine Co. similarly produced a brine from solar salt for the petroleum industry.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel estimated output remained essentially the same, but the value of that production increased nearly 20%.

In the Albuquerque area, increased demand for chip products prompted Albuquerque Gravel Products and Cemco Inc., to develop a vertical-shaft impact crusher to deliver a high-silica-content material at 125 to 150 short tons per hour. Crushing costs were reported to be 25 to 30 cents per ton, compared with $1.50 to $1.80 per ton using a standard hammer-type table. The company's sand and gravel deposit contained 80% to 90% silica with a compressive strength of 70,000 to 80,000 pounds per square inch.[5]

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for

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1986. Data for even-numbered years are based on annual company estimates.

Of the 48 quarries reporting output in 1987, 4 produced a dimension limestone and marble and 44 produced crushed limestone, granite, quartzite, traprock, and volcanic cinder and scoria. Operators quarried crushed and broken stone in 22 of the State's 33 counties.

Crushed.—The quantity of crushed stone produced in 1987 increased about 15% from that estimated in 1986 and value increased 4%. The leading producer of crushed rock in the State was Rock Products Inc. of Susanville, CA, doing business as Bee Bee Contractors and quarrying granite in Torrance County. Listed in descending order of tonnage, others quarrying limestone included G. F. Atkinson Co. in Eddy County, Ideal Basic in Bernalillo County, and K & B Constructors Inc. in Socorro County. There were 17 additional operators.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the two New Mexico districts depicted in figure 1.

Table 3.—New Mexico: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	290	1,555
Coarse aggregate, graded:		
Concrete aggregate, coarse	217	529
Bituminous aggregate, coarse	104	294
Fine aggregate (-3/8 inch):		
Stone sand, concrete	59	86
Screening, undesignated	21	47
Coarse and fine aggregates:		
Graded road base or subbase	903	3,449
Unpaved road surfacing	177	362
Terrazzo and exposed aggregate	326	418
Crusher run or fill or waste	16	47
Other construction[2]	737	2,839
Special: Other miscellaneous[3]	520	1,505
Other unspecified[4]	1,132	4,787
Total[5]	4,503	15,919

[1]Includes limestone, granite, traprock, volcanic cinder and scoria, quartzite, and marble.
[2]Includes filter stone, bituminous surface-treatment aggregate, and drain fields.
[3]Includes cement manufacture, flux stone, and roofing granules.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

Table 4.—New Mexico: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Coarse aggregate (1+1/2 inch)[1]	--	--	1,013	4,351
Coarse aggregate, graded[2]	112	307	217	553
Fine aggregate (-3/8 inch)[3]	W	W	W	W
Coarse and fine aggregates[4]	391	1,146	1,037	3,136
Other construction	22	22	58	111
Chemical and metallurgical[5]	(6)	(6)	(6)	(6)
Special[7]	(6)	(6)	(6)	(6)
Other miscellaneous	482	1,384	37	121
Other unspecified[8]	978	4,500	154	287
Total[9]	1,986	7,359	2,517	8,560

W Withheld to avoid disclosing individual company proprietary data; included with "Other construction."
[1]Includes riprap and jetty stone and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate.
[3]Includes stone sand (concrete) and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[5]Includes cement manufacture and flux stone.
[6]Withheld to avoid disclosing individual company proprietary data; included with "Other miscellaneous."
[7]Includes roofing granules.
[8]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[9]Data may not add to totals shown because of independent rounding.

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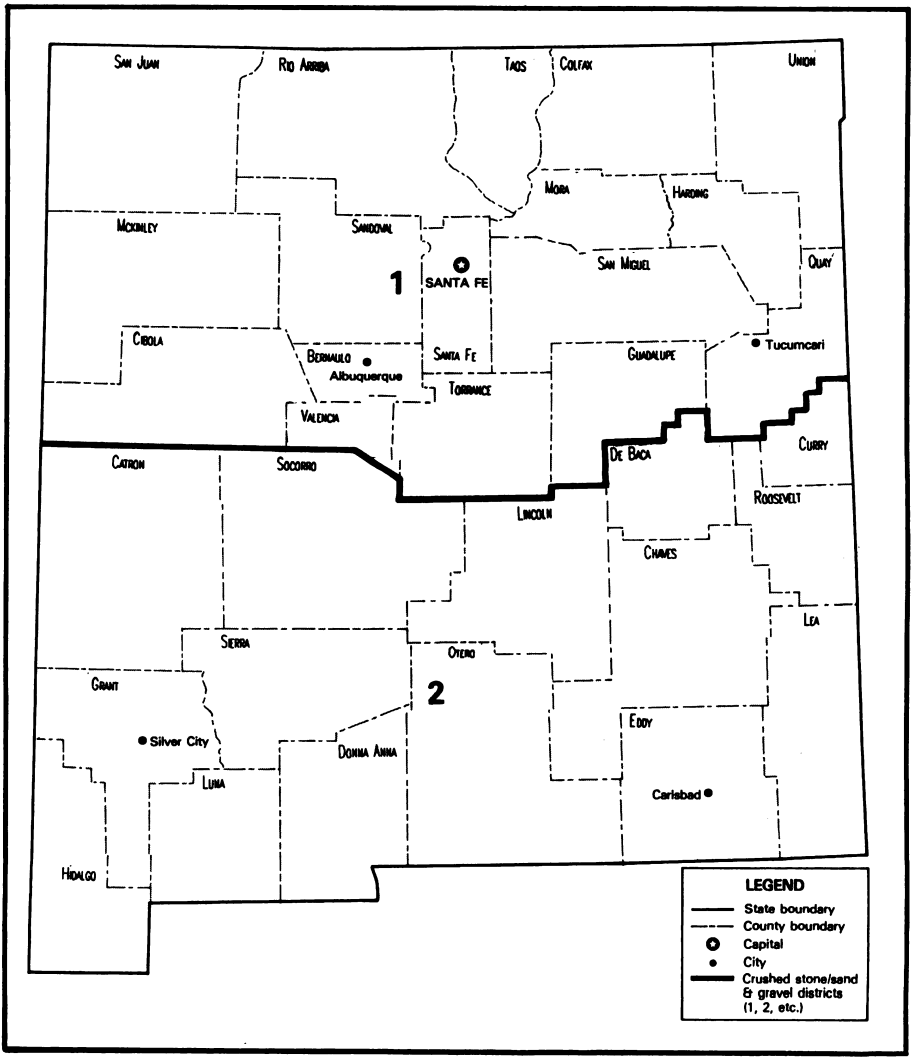

Figure 1.—Aggregate-producing districts in New Mexico.

Dimension.—Although the quantity of dimension stone quarried in 1987 remained the same as was estimated for 1986, its value climbed 66%. Dimension limestone was produced by Daniel F. Guillen Construction Inc. in Dona Ana County and by Mathis & Mathis Mining and Exploration in Grant County. Dimension marble (travertine) was quarried by Rocky Mountain Stone Co. in Valencia County and by Apache Springs Co. in Dona Ana County. Rocky Mountain Stone quarried various colors of a marble-travertine at its New Mexico travertine mine 20 miles from Belen. Italian polishing and cutting equipment purchased in 1985 could polish 80 slabs per day and cut slabs three-quarters of an inch thick.

Other Industrial Minerals.—Other industrial minerals included elemental sulfur

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recovered by Amoco Production Co., Marathon Oil Co., and Phillips Petroleum Co., in Eddy County; Chevron USA Inc., El Paso Natural Gas Co., Phillips Petroleum Co., and Northern Natural Gas Co., in Lea County; Cities Service Oil Co., in Roosevelt County; and El Paso Natural Gas in San Juan County. Output remained the same as in 1986, however, the value dropped 21% in 1987. Grade-A helium output gained about 17% in quantity and 15% in value. A private company, The Navajo Refined Helium Co., extracted and liquefied helium from natural gas at Shiprock, San Juan County. Major end uses of helium were cryogenics, welding, and pressurizing and purging. National Supply Co. shipped pyrites from its Peru Hill mine in Luna County.

[1]State Mineral Officer, Bureau of Mines, Denver, CO.
[2]Mining engineer, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM.
[3]New Mexico Labor Market Review. V. 17, No. 1, Feb. 29, 1988, p. 11.
[4]New Mexico Energy, Minerals and Natural Resources Department. Annu. Resour. Rep., 1988, p. 49.
[5]Michard, D. Modified Crusher Puts AGP in the Chips. Pit & Quarry, v. 79, No. 8, Feb. 1987, pp. 25-30.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ideal Basic Industries Inc., Ideal Cement Co.[1]	Box 100 Tijeras, NM 87059	Dry process, 2 rotary-kiln plants.	Bernalillo.
Clays:			
El Paso Brick Co. Inc	Box 12336 El Paso, TX 79913	Pit	Dona Ana.
Garcia & Sons Inc[1]	Box 841 Farmington, NM 87401	Pit	San Juan.
Mathis & Mathis Mining & Exploration Co.[1]	Box 2577 Silver City, NM 88062	Pit	Luna.
New Mexico Brick Co. Inc. (doing business as Kinney Brick Co. Inc.).	Box 1804 100 Prosperity Ave., SE. Albuquerque, NM 87103	Pit	Bernalillo.
Copper:			
Burro Chief Copper Co., a subsidiary of Phelps Dodge Corp.	Drawer B Tyrone, NM 88065	Solvent extraction-electrowinning plant.	Grant.
Chino Mines Co., a subsidiary of Phelps Dodge Corp.-Mitsubishi Metal Corp. partnership.[2 3]	Box 7 Hurley, NM 88043	Surface pit mine, flotation mill, precipitation plant, smelter.	Do.
Cyprus Pinos Altos Corp.[4]	Box 2198 Silver City, NM 88062-2198	Underground mine and mill.	Do.
Phelps Dodge Corp.:			
Hidalgo Smelter[5]	Box 67 Playas, NM 88009	Smelter	Hidalgo.
Tyrone Branch[3]	Drawer B Tyrone, NM 88065	Surface mine, mill, solvent extraction-electrowinning plant.	Grant.
Gold:			
Westar Resources Inc	Drawer D Lordsburg, NM 88045	Surface mine, heap-leach operation.	Hidalgo.
Gypsum:			
Centex American Gypsum Co	Box 6345, Station B Albuquerque, NM 87197	Pit and plant	Bernalillo and Sandoval.
Ernst Teeter Trucking Inc	Box 27317 Albuquerque, NM 87125	Pit	Sandoval.
Western Gypsum	Box 2636 Santa Fe, NM 87501	Pit and plant	Santa Fe.
Mica:			
Mineral Industrial Commodities of America Inc.	Box 2403 Santa Fe, NM 87504	Pit and mill	Rio Arriba and Taos.
Perlite:			
Grefco Inc., Minerals Div., a subsidiary of General Refractories Co.	Box 308 Antonito, CO 81120	Surface mines; crushing, screening, air separation.	Socorro and Taos.
Manville Sales Corp., a division of Manville Products Corp.	Box 338 Antonito, CO 81120	____do	Taos.
Silbrico Corp	Box 367 Antonito, CO 81120	Surface mine	Do.
United States Gypsum Co., a subsidiary of USG Corp.	Box 216 Grants, NM 87020	Surface mine and crushing plant.	Cibola.
Potash:			
AMAX Potash Corp., a subsidiary of AMAX Inc.	Box 279 Carlsbad, NM 88220	Underground mine and plant.	Eddy.
IMC Fertilizer Inc. of International Minerals & Chemical Corp.	Box 71 Carlsbad, NM 88220	____do	Do.
Lundberg Industries Ltd	Box 31 Carlsbad, NM 88220	____do	Do.
New Mexico Potash Corp. of Cedar Chemical Inc.[6]	Box 610 Hobbs, NM 88240	____do	Lea.
Western Ag-Minerals Co., a partnership of Warburg-Pincus Capital Partners and Rayrock Resources Ltd.	Box 511 Carlsbad, NM 88220	____do	Eddy.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Pumice:			
American Pumice Co., a division of Continental Equities Corp.	Box 4305 Santa Fe, NM 87502	Mill	Santa Fe.
Copar Pumice Co. Inc	Box 38 Espanola, NM 87532	Surface mine	Do.
General Pumice Corp	Box 5135 Santa Fe, NM 87502	Surface mine and crushing and screening plant.	Rio Arriba and Santa Fe.
Utility Block Co	7200 2d St., NW. Box 6036 Albuquerque, NM 87197	Surface mines and crushing and screening plants.	Bernalillo and Sandoval.
Salt:			
New Mexico Salt & Minerals Corp	Box 2262 Carlsbad, NM 88220	Salt lake	Eddy.
Unichem International Co	Box 1196 Eunice, NM 88321	Brine	Lea.
United Salt Corp., Carlsbad Div	Box SS Carlsbad, NM 88220	Salt lake	Eddy.
Williams Brine Co	851 Standpipe Rd. Carlsbad, NM 88220	Brine	Lea.
Sand and gravel:			
Aggregate Specialists of New Mexico	4825 Jefferson, NE. Albuquerque, NM 87109	Pit and plant	Sandoval.
Albuquerque Gravel Products Co	Box 829 Albuquerque, NM 87103	Dredge and plant	Bernalillo.
Albuquerque Materials Inc	Box 6098, Station B Albuquerque, NM 87197	Pit and plant	Do.
Armstrong & Armstrong	Box 1873 Roswell, NM 88201	do	Chaves.
Connie H. Danley Construction Inc	Drawer K Alamogordo, NM 88310	do	Otero.
J. R. Hale Contracting Co. Inc	Box 25667 Albuquerque, NM 87125	do	Sandoval.
S & S Aggregates Inc	Box 14379 Albuquerque, NM 87111	do	Bernalillo.
Springer Building Materials Corp.[1]	Box 572 Albuquerque, NM 87103	do	Do.
Silver:			
St. Cloud Mining Co., a subsidiary of The Goldfield Corp., Melbourne, FL.[7]	Box 1670 Truth or Consequences, NM 87901	Underground and surface mines, mill.	Sierra.
Stone:			
Crushed:			
G. F. Atkinson Co. of Monterey Construction Co.	Box 2248 Carlsbad, NM 88221	Quarries	Eddy.
Beavers Sand & Gravel Inc	Box 887 Ruidoso Downs, NM 88346	Quarry	Lincoln.
Big Chief Stone Inc	900 North Morton Lane Las Cruces, NM 88005	Quarries	Colfax, Dona Ana, Santa Fe.
El Paso Sand Products Inc	Box 9008 El Paso, TX 79982	Quarry	Dona Ana.
K & B Constructors Inc	1437 Furneaux Rd. Marysville, CA 95901	do	Socorro.
Rock Products Inc. (doing business as Bee Bee Contractors).	Box 154 Encino, NM 88321	do	Torrance.
Rose Gravel Co	Box 220 Carlsbad, NM 88220	Quarries	Chaves and Eddy.
Thomason Construction Co	Box 339 Hobbs, NM 88240	Quarry	Lea.
Dimension:			
Apache Springs Co	Radium Springs, NM 88054	do	Dona Ana.
Daniel F. Guillen Construction Inc.	4007 Mission Bell Las Cruces, NM 88001	do	Do.
Rocky Mountain Stone Co	Box 6608 Albuquerque, NM 87197	Quarries	Socorro and Valencia.
Uranium-Vanadium:			
Chevron Resources Co	Box 1150 Grants, NM 87020	Underground mine	Cibola.
Homestake Mining Co	Box 98 Grants, NM 87020	Underground mines, concentrator, ion-exchange from mine waters.	Cibola and McKinley.
Quivira Mining Co	Box 218 Grants, NM 87020	do	Do.
Ray L. Williams Mining Co	7 Road 5455 Farmington, NM 87401	Underground mine	San Juan.

[1]Also stone.
[2]Also byproduct molybdenum.
[3]Also gold and silver.
[4]Also gold, lead, and silver.
[5]Also fire clay and quartzite.
[6]Also salt.
[7]Also lead and copper.

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The Mineral Industry of New York

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New York State Education Department, New York Geological Survey, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and William M. Kelly[2]

The value of nonfuel mineral production in New York was $650.4 million, a $27.2 million decrease from that of 1986. Leading mineral commodities produced in terms of value were crushed stone, portland cement, salt, construction sand and gravel, and wollastonite. Mineral commodities processed or manufactured but not in the State's total value in table 1 included abrasives, ferroalloys, graphite, iodine, mullite, perlite, slag, steel, and vermiculite.

Nationally, the State ranked 14th in the value of nonfuel minerals produced. New York was the only State that produced emery and it accounted for most of the Nation's wollastonite production. The State ranked first in synthetic graphite production; second in primary aluminum, garnet, and zinc; third in salt, and fourth in talc production.

Table 1.—Nonfuel mineral production in New York[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	700	$3,129	619	$3,075	673	$3,562
Emery ---------- short tons	W	W	2,878	W	1,945	W
Gem stones	NA	e30	NA	100	NA	135
Peat ---------- thousand short tons	W	W	W	W	1	34
Salt ---------- do	7,044	142,318	5,071	122,601	4,918	119,962
Sand and gravel:						
Construction ---------- do	e28,000	e88,500	31,172	103,748	e31,400	e112,900
Industrial ---------- do	W	W	59	1,164	58	651
Stone:						
Crushed ---------- do	35,139	165,136	e40,600	e196,600	38,103	188,694
Dimension ---------- do	16	3,666	e16	e3,002	39	5,822
Combined value of cement, garnet (abrasive), gypsum, lead, lime (1985), silver, talc, wollastonite, zinc, and values indicated by symbol W ----------	XX	254,529	XX	247,272	XX	218,620
Total ----------	XX	657,308	XX	677,562	XX	650,380

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers). "Combined value" data.

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Table 2.—Nonfuel minerals produced in New York in 1986, by county[1]

County	Minerals produced in order of value
Albany	Cement, clays, sand and gravel.
Allegany	Sand and gravel.
Broome	Sand and gravel, peat, clays.
Cattaraugus	Sand and gravel, peat.
Cayuga	Sand and gravel.
Chautauqua	Do.
Chemung	Do.
Chenango	Do.
Clinton	Do.
Columbia	Do.
Cortland	Do.
Delaware	Do.
Dutchess	Do.
Erie	Sand and gravel, clays.
Essex	Wollastonite, iron ore, sand and gravel.
Franklin	Sand and gravel.
Fulton	Do.
Genesee	Gypsum, sand and gravel.
Greene	Cement, sand and gravel.
Herkimer	Sand and gravel.
Jefferson	Do.
Lewis	Wollastonite, sand and gravel.
Livingston	Salt, sand and gravel.
Madison	Sand and gravel.
Monroe	Do.
Montgomery	Do.
Oneida	Sand (industrial).
Onondaga	Sand and gravel, clays.
Ontario	Sand and gravel.
Orange	Sand and gravel, clays.
Orleans	Sand and gravel.
Oswego	Do.
Otsego	Do.
Putnam	Do.
Rensselaer	Do.
St. Lawrence	Zinc, talc, sand and gravel, lead, silver.
Saratoga	Sand (industrial).
Schenectady	Sand and gravel.
Schoharie	Cement, sand and gravel.
Schuyler	Salt, sand and gravel.
Seneca	Sand and gravel, peat.
Steuben	Sand and gravel.
Suffolk	Do.
Sullivan	Do.
Tioga	Do.
Tompkins	Salt, sand and gravel.
Ulster	Sand and gravel, clays.
Warren	Cement, sand and gravel, abrasives.
Washington	Sand and gravel.
Wayne	Do.
Westchester	Peat, sand and gravel.
Wyoming	Salt, sand and gravel.
Yates	Sand and gravel.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—In late December 1987, the New York State Court of Appeals decided that local zoning was not superseded by State law for the purpose of regulating mining. The high court upheld a decision earlier in the year by the Fourth Department of Appellate Division, which gave towns the right to prohibit mining by local zoning, even though a mining concern held a mining permit from the State Department of Environmental Conservation (DEC). The court also said that stricter local standards for the reclamation of mined lands were consistent with the overall aim of the Mined Land Reclamation Law in protecting the environment.

Chapter 410, approved and effective in July, amended the environmental conservation law in relation to deep geothermal, stratigraphic, and brine disposal wells. The new law regulates the development, production, and utilization of oil, gas, and brine wells in such a manner as to prevent waste and result in greater ultimate recovery.

Several of the laws passed in 1987 addressed hazardous- and solid-waste disposal. Chapter 489, effective on July 30, established the New York State Center for Hazardous Waste Management. Chapter 618, approved in August, amended the environmental conservation law and established a

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policy of preferred statewide hazardous-waste management practices and a statewide hazardous-waste-facility siting plan. Chapter 464 amended the environmental conservation law concerning solid-waste recovery and management.

In September, the DEC announced a major reorganization to address the most critical issues facing the State's environment—solid-waste management and the remediation of hazardous waste sites. Under the reorganization, three separate divisions were created: the Division of Solid Waste, the Division of Hazardous Waste Remediation, and the Division of Hazardous Substances Regulation. Previously, all three functions were combined under the Division of Solid and Hazardous Waste.

The Division of Solid Waste would focus on the issues of waste reduction, recycling, waste-to-energy plants, and landfilling. The Division of Hazardous Waste Remediation would oversee the cleanup of inactive toxic-waste sites with the assistance of the largest State Superfund program in the Nation. The Division of Hazardous Substances Regulation will continue to administer programs for the regulation of hazardous and low-level radioactive wastes.

In 1987, major projects of the New York Geological Survey included the study of statewide landslide and slope stability problems, low-level radioactive waste disposal, and radon gas in residential structures. Regional geologic investigations included aggregate and heavy-mineral resource evaluation in marine offshore areas funded by the Minerals Management Service of the U.S. Department of the Interior, Cambro-Ordovician biostratigraphy funded by the National Science Foundation, and a seismic investigation of the structure of the Adirondack Mountains.

Under the ongoing State Mining and Mineral Resources Research Institute Program Act, the U.S. Bureau of Mines allotted an allotment grant of $138,000 to Columbia University's Henry Krumb School of Mines to conduct research and training in the mineral-related disciplines. The State must match the grant to the university on a 2-to-1 basis.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Four companies operated four cement plants in the State. Both portland and masonry cement were produced by Atlantic Cement Co. Inc. at Ravena, Lehigh Portland Cement Co. at Cementon, and the Glens Falls Portland Cement Co. Inc. at Glens Falls. Only portland cement was produced at the Independent Cement Corp.'s plant at Catskill. In 1987, shipments and value of portland cement fell 11% and 17%, respectively. Shipments and value of masonry cement rose 36% and 21%, respectively. Most of the cement was shipped by barge; rail and truck also were used.

In March, the Atlantic Cement Co. proposed to renovate the Ravena cement plant so that it could use as secondary fuels various types of hazardous liquid wastes, such as painting and printing residue, solvent sludges, off-specification refinery products, and waste oil. Coal would continue to be the plant's primary fuel. Atlantic, along with the Ohio-based Systech Corp., which will be in charge of burning the waste, has proposed such wastes provide approximately 35% of the heat needed for the cement plant operation. According to Systech, the hazardous materials would be destroyed by the high temperatures, thereby avoiding any adverse environmental damage. Atlantic was preparing an environmental impact statement, to be submitted to the DEC for approval.

Clays.—In 1987, production and value of common clay increased 9% and 16%, respectively. The clay was produced at nine pits in six counties and was used principally in the manufacture of portland cement, face brick, concrete block, and structural cement.

Emery.—New York was the only State that produced emery. One company, John Leardi Emery Mine, operated a mine near Peekskill in Westchester County. The crude material was processed by two out-of-State companies—Washington Mills Abrasive Co., North Grafton, MA; and Emeri-Crete Inc., New Castle, NH. The emery was principally used as an abrasive aggregate for nonskid, wear-resistant floors, pavements, and stair treads. Minor uses were as coated abrasives and tumbling or deburring media.

Garnet.—Four domestic producers were active in 1987, two in New York and one each in Idaho and Maine. Barton Mines Corp., Warren County, produced garnet for use in coated abrasives, glass grinding and polishing, and metal lapping. The NYCO Div. of Processed Minerals Inc., Essex County, reported that crude garnet concentrate

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was recovered as a byproduct at its Essex County wollastonite operation and was sold to a U.S. garnet producer for refinement and sale.

Gem Stones.—Based on a survey by the curator of mineralogy of the New York State Museum, the value of gem stones and mineral specimens collected by mineral dealers and amateur collectors in New York was estimated at $125,000 in 1987. Of this amount, approximately $88,000 entered the market as specimens and educational-grade samples and $37,000 remained in private collections and museums. Popular gem- and mineral-collecting areas included Gore Mountain near North Creek, Warren County; sphalerite, galena and talc refuse areas from mines operating near Balmat, St. Lawrence County; and southern Herkimer County where "Herkimer Diamonds," doubly terminated clear quartz crystals, are found. Heightened public interest in the purported healing aspects of quartz had greatly increased the value of these crystals.

Gypsum.—The only producer of crude gypsum in New York was USG Corp. at an underground operation at Oakfield, Genesee County. Output and value of crude gypsum increased 9% and 20%, respectively. The crude gypsum mined at Oakfield was calcined and made into wallboard at an adjoining plant.

Imported gypsum was also calcined in the State at three plants. USG calcined gypsum imported from Nova Scotia at a plant in Stony Point, Rockland County. In terms of total output, the Stony Point plant ranked ninth of 72 plants that calcined gypsum in the United States. Two other companies also calcined gypsum using imported ore. National Gypsum Co. operated a plant in Rensselaer, Rensselaer County, and Georgia-Pacific Corp. operated a plant at Buchanan in Westchester County. Total gypsum calcined in the State in 1987 was slightly more than 1 million tons valued at nearly $19 million.

Peat.—Four companies produced peat at four operations—two in Seneca County and one each in Broome and Westchester Counties. Both reed sedge and humus were sold for soil improvement and as an ingredient in potting soils.

Salt.—New York ranked third in output and first in value of the 15 States that produced salt in 1987. Salt sold or used totaled 4.9 million short tons (13% of the Nation's total) valued at nearly $120 million. Both rock salt and brine were produced by four companies at six operations in four counties. Rock salt was produced by Cargill Inc. in Tompkins County and by International Salt Co. (ISC) in Livingston County. Evaporated salt also was produced by Cargill and ISC, each operating a plant in Schuyler County, and by Morton Thiokol Inc. in Wyoming County.

In December, ISC filed suit in U.S. District Court, Rochester, against a proposal by Integrated Waste Systems of Buffalo, acting with and for a French company called Geostock, to fill mined-out cavities of ISC's Retsof salt mine in Livingston County. The 12-foot-high cavities, 1,200 feet below the surface, would be filled with ash from coal-fired powerplants and solid-waste incinerators. ISC, which was mining salt in the adjacent area, opposed the project. It claimed that the dumping of the ash would create an unsafe situation because the empty cavities were used for ventilation. ISC also contended that the developers' purchase of "cavity rights" could conflict with its claim to mineral rights to the underground land in and around the cavities. Geostock acquired surface and underground cavity rights to 10,000 acres of mined-out sections of the salt mine. Geostock planned to file an application with the New York Department of Environmental Conservation for a permit for the dumping.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Based on these estimates, output and value of construction sand and gravel remained essentially the same as that of 1986. More than 350 companies mined construction sand and gravel from 420 operations in 53 counties. Leading counties, in order of output, were Suffolk, Rensselaer, Cattaraugus, Dutchess, and Orange. Main uses were for road base and coverings, concrete aggregate, and fill.

In December, Basins Inc., a manufacturer of play sand in Gouverneur, voluntarily withdrew the product after the State Department of Health identified small amounts of asbestos or asbestoslike fibers in the sand. The sand was marketed under the brand names of Basins, Hyponex, and Becks.

Industrial.—Whitehead Bros. Co. was the only industrial sand producer in New York in 1987. The company operated two pits, in

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Saratoga and in Oneida Counties. Production was virtually the same as in 1986. Major uses were for glassmaking, moldings, and foundry purposes.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone, the State's leading mineral commodity, accounted for nearly 30% of the State's total nonfuel mineral value. In 1987, both quantity and value decreased approximately 4%.

Limestone accounted for almost 75% of the crushed stone produced in the State. Other rock types produced included dolomite, granite, sandstone, slate, and traprock. Main uses for crushed stone were for road base, bituminous aggregate, cement manufacture, and fill.

In 1985, the U.S Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the eight New York districts depicted in figure 1.

Table 3.—New York: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	171	1,418
Riprap and jetty stone	483	2,350
Filter stone	124	477
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,321	6,119
Bituminous aggregate, coarse	4,763	23,158
Bituminous surface-treatment aggregate	896	4,214
Railroad ballast	547	2,822
Fine aggregate (-3/8 inch):		
Stone sand, concrete	892	5,551
Stone sand, bituminous mix or seal	402	1,751
Screening, undesignated	367	1,795
Coarse and fine aggregates:		
Graded road base or subbase	3,712	16,828
Unpaved road surfacing	100	507
Crusher run or fill or waste	2,376	9,300
Other construction[2]	5,284	37,414
Agricultural:		
Agricultural limestone	123	948
Other agricultural uses	W	211
Chemical and metallurgical:		
Cement manufacture	4,019	9,802
Lime manufacture	W	92
Special:		
Other fillers and extenders	W	65
Roofing granules	W	23
Other miscellaneous	926	3,605
Other unspecified[3]	11,597	60,234
Total	38,103	[4]188,694

W Withheld to avoid disclosing company proprietary data; included in "Other miscellaneous."
[1]Includes limestone, dolomite, sandstone, granite, slate, traprock, and marble.
[2]Includes coarse aggregate (large), terrazzo and exposed aggregate, lightweight aggregate, and drain fields.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

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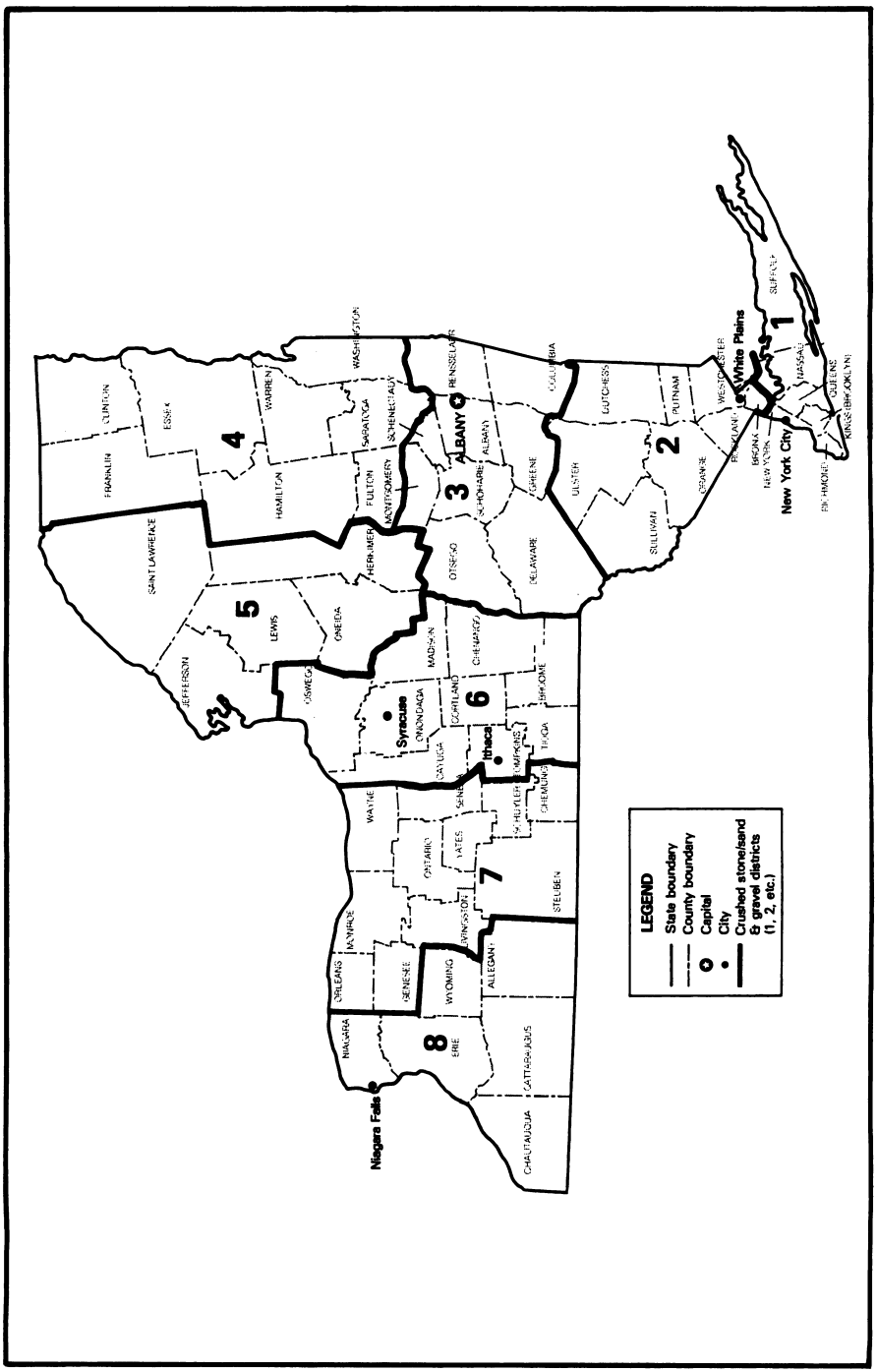

Figure 1.—Aggregate-producing localities in New York.

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Table 4.—New York: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	--	--	W	W	239	1,185	W	W
Coarse aggregate, graded[2]	--	--	1,727	12,151	1,934	9,426	1,011	3,998
Fine aggregate (-3/8 inch)[3]	--	--	752	5,062	279	1,538	--	--
Coarse and fine aggregates[4]	--	--	568	3,625	918	4,167	W	W
Other construction[5]	--	--	5,152	36,671	--	--	441	1,358
Agricultural[6]	--	--	--	--	24	182	(7)	2
Chemical and metallurgical[9]	--	--	--	--	(7)	(7)	(7)	(7)
Special[10]	--	--	--	--	--	--	--	--
Other miscellaneous	--	--	--	--	4,105	11,683	769	1,523
Other unspecified[11]	--	--	3,546	23,828	--	--	400	1,344
Total[12]	--	--	11,745	81,336	7,499	28,182	2,621	8,225

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	60	394	29	142	226	864	14	37
Coarse aggregate, graded[2]	1,201	4,661	W	W	742	2,971	W	W
Fine aggregate (-3/8 inch)[3]	80	347	74	358	435	1,698	40	94
Coarse and fine aggregates[4]	1,016	3,498	251	975	1,066	4,387	W	W
Other construction[5]	55	307	414	2,149	26	174	2,684	11,465
Agricultural[6]	47	405	(8)	(8)	(8)	(8)	26	70
Chemical and metallurgical[9]	5	92	--	--	--	--	--	--
Special[10]	3	65	--	--	--	--	8	23
Other miscellaneous	36	200	--	--	--	--	--	--
Other unspecified[11]	1,563	7,130	1,657	6,939	2,497	13,398	1,982	8,104
Total[12]	4,067	17,101	2,423	10,564	4,993	23,492	4,755	19,794

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, drain fields, and crusher run or fill or waste.
[5]Includes lightweight aggregate.
[6]Includes agricultural limestone and other agricultural uses.
[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[8]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[9]Includes cement manufacture and lime manufacture.
[10]Includes other fillers or extenders and roofing granules.
[11]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[12]Data may not add to totals shown because of independent rounding.

Dimension.—Dimension stone was produced by 16 companies operating 23 quarries in 8 counties. The majority of the production was in Washington County, with nine operations. Other counties that produced dimension stone included Albany, Delaware, Essex, Franklin, Orleans, Tompkins, and Westchester. Both production and value of dimension stone rose considerably in 1987. Output more than doubled to 38,553 short tons in 1987. Value of the stone produced in 1987 rose nearly 94%. New York ranked second of 17 States, after Ohio, that produced dimension sandstone. Nearly two-thirds of the dimension stone quarried in New York was sandstone. Other dimension stone quarried included granite, limestone, quartzite, and slate.

Talc.—New York ranked fourth of 10 States that produced talc in 1987. The Gouverneur Talc Co. Inc., a subsidiary of R. T. Vanderbilt Co. Inc., mined talc from both a surface and an underground operation in St. Lawrence County. The ore was ground and processed at an on-site mill and used primarily for ceramics and paint additives.

Wollastonite.—New York continued to lead the Nation in the production of wollastonite, accounting for nearly all of the Nation's output. Two companies mined wollastonite in the State in 1987. The largest producer, NYCO, operated the Lewis surface mine 14 miles west of Willsboro, Essex County. Early in the year, the company announced plans to construct a new plant at Willsboro for the production of chemically modified minerals, including wollastonite. The proposed new facility was scheduled to be completed in 1988.

R. T. Vanderbilt, the State's other produc-

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er, owned a surface and underground mine near Lewis, Essex County. The mine was operated by Vanderbilt's talc mining subsidiary, Gouverneur Talc Co. Inc.

Both output and value of wollastonite increased in 1987. NYCO and Vanderbilt supplied most of the domestic market and shipped about 40% of their production to Europe and Japan. The declining value of the U.S. dollar had encouraged higher wollastonite sales overseas.

MANUFACTURED OR PROCESSED MINERALS

In addition to the commodities listed in table 1, the production and value of some processed or manufactured mineral commodities were also surveyed by the U.S. Bureau of Mines.

High-purity fused aluminum oxide was produced by Electro Minerals (US) Inc. and by General Abrasives Div. of Dresser Industries Inc., both in Niagara Falls. General Abrasives also produced regular fused aluminum oxide. Almost all of the combined output of high-purity and regular material was for abrasive applications. Cut wire shot used for abrasives was produced by Pellets Inc. at a plant in Tonawanda, Erie County. New York ranked first among 16 States that manufactured graphite. Three companies in Niagara County produced graphite. Principal uses were for anodes, cathodes, electrodes, and for crucibles and vessels. Crude iodine shipped into the State was processed by Sterling Organics, Rensselaer County, for the manufacture of pharmaceuticals, catalysts, and sanitary products. Electric-furnace-fused mullite was produced by Electro Minerals U.S. Inc. at Niagara Falls. The mullite was primarily used by the steel industry for furnace linings. Crude perlite shipped in from other States was expanded by Buffalo Perlite, Erie County, and by Solite International Corp., Rensselaer County. The expanded perlite was used in lightweight building plaster, loose fill insulation, soil conditioning, and filtration. Buffalo Crushed Stone Corp., Buffalo, processed air-cooled iron slag and sold the material for road base and asphaltic concrete aggregate. W. R. Grace & Co. exfoliated vermiculite concentrate, shipped in from out of State, at its plant in Weedsport, Cayuga County. The exfoliated vermiculite was primarily used for loose fill insulation, horticulture, lightweight concrete aggregate, and soil conditioning.

METALS

Aluminum.—In 1987, New York ranked second in output and value, after Washington, among the 15 States that had primary aluminum facilities. Two companies, both in Massena, St. Lawrence County, operated plants. Reynolds Metals Co. operated a 114,000-metric-ton-per-year smelter at full capacity and Aluminum Co. of America (Alcoa) operated a 205,000-metric-ton-per-year plant at two-thirds capacity (127,000 metric tons).

Near yearend, the Rochester Aluminum Smelting Corp. purchased the physical assets of Rochester Smelting & Refining Co. Inc.'s secondary aluminum plant in Rochester, which had been idle since November 1986. The 3-million-pound-per-month plant was expected to process scrap on a tolling basis.

Metal Container Corp., a wholly owned subsidiary of Anheuser-Busch Inc., began work on a new aluminum can plant in Chester that will be capable of producing more than 2 billion cans per year. Metal Container's customers for the new plant would include three of the parent company's northeastern breweries.

Iron and Steel.—Officials at Al Tech Specialty Steel Corp. confirmed industry reports that the company was continuing to melt and continuously cast specialty billets at its Watervliet mill, despite a plan announced in the summer of 1986 to discontinue these operations and furlough 400 hourly employees. In July 1986, the new owner of Al Tech, Rio Algom Ltd., Toronto, Canada, had immediate plans to dismantle the Watervliet caster and move it to its Atlas Steel Div. plant in Welland, Ontario. This would effectively shut down the melting and continuous casting at Watervliet. However, the company did note that its long-term objective was to stop melting at Watervliet once the Welland plant was fully operational.

In March, officials of United Steelworkers of America (local 6599) proposed to form a management team to reopen Roblin Steel's minimill in Dunkirk. The proposal was one of several being studied. The Chautauqua County Industrial Development Agency paid for the feasibility study to provide information on the best way to bring about the reopening of the steel plant. The union's plan would permit the Dunkirk plant to continue to supply special bar products and also would involve concentrating on larger size bars where Roblin had a competitive edge.

Adirondack Foundries Inc., which had been operating under chapter 11 of the

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Federal Bankruptcy Code since June, announced in September that it was phasing out its steel-casting operations in Colonie and will begin liquidating its assets. Adirondack, a 70-year-old company, had 25 people working at a facility that employed as many as 400 just 5 years ago.

Lead.—Lead was recovered as a byproduct at Zinc Corp. of America's zinc operations in St. Lawrence County.

Zinc.—New York ranked second in the Nation after Tennessee in zinc output. Although production fell by 4% in 1987, value rose slightly more than 6%.

In mid-September, Horsehead Industries Inc. became the largest domestic zinc producer when it acquired Fluor Corp.'s subsidiary, St. Joe Resources Co., at a cost of about $100 million that included $38 million in debt. The St. Joe operations—two mines and a mill in Balmat and Pierrepont and two out-of-State smelters, were combined with those of Horsehead's New Jersey Zinc Co. Inc., to form a new company called Zinc Corp. of America.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

[2]Senior scientist, New York Geological Survey, Albany, NY.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
Electro Minerals (U.S.) Inc	1801 Buffalo Ave., Box 423 Niagara Falls, NY 14302	Plant	Niagara.
General Abrasives Div. of Dresser Industries Inc.	2000 College Ave. Niagara Falls, NY 14305	do	Do.
Pellets Inc	531 South Niagara St. Tonawanda, NY 14150	do	Erie.
Aluminum (primary):			
Aluminum Co. of America	1210 Alcoa Bldg. Pittsburgh, PA 15222	Smelter	St. Lawrence.
Reynolds Metals Co	Box 27003-2A Richmond, VA 23215	do	Do.
Cement:			
Atlantic Cement Co. Inc., a subsidiary of Newmont Mining Corp.[1 2]	Box 3 Ravena, NY 12143	Quarry and plant.	Albany.
The Glens Falls Portland Cement Co. Inc., a subsidiary of Moore McCormack Resources Inc.[1]	Box 440 Glens Falls, NY 12801	Quarries and plants.	Schoharie and Warren.
Independent Cement Corp	Box 12-310 Albany, NY 12212	Quarry and plant.	Greene.
Lehigh Portland Cement Co.[1]	718 Hamilton Mall Allentown, PA 18105	do	Do.
Clays:			
Norlite Corp., a subsidiary of P.J. Keating Co.	Box 367 Fitchburg, MA 01420	Pit	Albany.
Northeast Solite Corp., a subsidiary of Solite Corp.	Box 27211 Richmond, VA 23261	Pit	Ulster.
Powell & Minnock Brick Works Inc	Route 144 Coeymans, NY 12045	Pit	Albany.
Emery:			
John Leardi Emery Mine	Gillman Lane Peekskill, NY 10566	Pit	Westchester.
Garnet:			
Barton Mines Corp	North Creek, NY 12853	Pit	Warren.
Gypsum:			
Calcined:			
Georgia-Pacific Corp	Box 105605 133 Peachtree St., NE. Atlanta, GA 30348	Plant	Westchester.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	do	Rensselaer.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	Plants	Genessee and Rockland.
Crude:			
USG Corp	101 South Wacker Dr. Chicago, IL 60606	Underground mines.	Genesee.
Iron ore:			
NL Chemicals Inc	Tahawus, NY 12879	Pit	Essex.
Peat:			
Finger Lakes Peat Moss Co	R.D. 2 Phelps, NY 14532	Bog	Seneca.
Malcuria Bros. Inc	1436 Gates Rd. Geneva, NY 14456	Bog	Do.
Bob Murphy Inc	3129 Vestal Rd. Vestal, NY 13850	Bog	Broome.
Stone Age Humus Corp	Box 191 Armonk, NY 10504	Bog	Westchester.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite (expanded):			
Buffalo Perlite Corp	100 Sugg Rd. Buffalo, NY 14224	Plant	Erie.
Solite International Corp	6 Madison St. Troy, NY 12181	do	Rensselaer.
Salt:			
Dale Brine Co., Div. of Occidental Chemical.	360 Rainbow Blvd. South Niagara Falls, NY 14303	Well	Wyoming.
Cargill Inc	Box 5621 Minneapolis, MN 55440	Underground mine.	Tompkins.
International Salt Co	Clarks Summit, PA 18411	Underground mines.	Livingston and Schuyler.
Morton Thiokol Inc	110 North Wacker Dr. Chicago, IL 60606	Well	Wyoming.
Sand and gravel:			
Broad Hollow Estates Inc	Box 483 Farmingdale, NY 11735	Pit	Suffolk.
Buffalo Crushed Stone Inc	2544 Clinton St. Buffalo, NY 14224	Pits	Cattaraugus.
McCormack Sand Co	Box 448 Port Washington, NY 11050	Pit	Nassau.
Slag—iron:			
Buffalo Crushed Stone Corp.[2]	2544 Clinton St. Buffalo, NY 14224	Plant	Erie.
Stone:			
Crushed:			
Blue Circle Atlantic Inc	Box 3 Ravena, NY 12143	Quarry	Albany.
Callahan Industries Inc	South St. South Bethlehem, NY 12161	Quarries	Albany, Madison, Rensselaer, Ulster.
Dolomite Products Inc	1150 Penfield Rd. Rochester, NY 14625	do	Genesee and Ulster.
The General Crushed Stone Co., a subsidiary of Koppers Co. Inc.	Box 231 Easton, PA 18042	do	Herkimer, Jefferson, Livingston, Onondaga, Ontario, Wayne.
New York Trap Rock Corp., a subsidiary of Lone Star Industries Inc.	Box 432 Montvale, NJ 07645	Quarry	Rockland.
Peckham Materials Corp	20 Haarlem Ave. White Plains, NY 10603	Quarries	Greene, Putnam, Warren, Washington.
Tilcon Quarries Inc	Box 362 Haverstown, NY 10927	do	Rockland and Ulster.
Dimension:			
Champlain Stone Ltd	Box 852 Glens Falls, NY 12801	Quarry	Washington.
Finger Lakes Stone Co. Inc	Box 401 Ithaca, NY 14850	do	Tompkins.
Lake Placid Granite Co	202 South 3d Ave. Cold Spring, MN 56320	do	Essex.
Medina Sandstone Quarry Inc	8875 Quarry Rd. Niagara Falls, NY 14304	do	Orleans.
New York Quarries Inc	Box 43, Route 111 Alcove, NY 12007	Quarries	Albany and Delaware.
Rainbow Quarries Inc	132 E. Main St. Malone, NY 12953	Quarry	Franklin.
Talc:			
Gouverneur Talc Co. Inc., a subsidiary of R. T. Vanderbilt Co. Inc.	Box 89 Gouverneur, NY 13642	Underground mine.	St. Lawrence.
Vermiculite:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Cayuga.
Wollastonite:			
NYCO Div. of Processed Minerals Inc.[3]	Box 368 Willsboro, NY 12996	Surface mine	Essex.
R. T. Vanderbilt Co. Inc	30 Winfield St. Norwalk, CT 06855	Surface and underground mine.	Lewis.
Zinc:			
Zinc Corp. of America[4]	Balmat, NY 13607	Underground mines.	St. Lawrence.

[1]Also clays.
[2]Also stone.
[3]Also garnet.
[4]Also byproduct lead.

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The Mineral Industry of North Carolina

The chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Division of Land Resources, North Carolina Department of Natural Resources and Community Development, for collecting information on all nonfuel minerals.

By Doss H. White, Jr.[1] and Albert Carpenter III[2]

In 1987, the value of North Carolina's nonfuel mineral production totaled $477 million, another record year for the State's mineral producers. Construction sand and gravel and crushed stone accounted for $267 million or 56% of the total. Although production increased for many mineral commodities mined in the State, output fell for feldspar, lithium, olivine, industrial sand, and dimension stone. North Carolina continued to lead the Nation in the production of feldspar, mica, lithium (spondumene), olivine, and pyrophyllite, and ranked second in common clay, crushed granite, and phosphate rock output.

During the year exploration and/or beneficiation studies were under way at four metallic ore bodies. In the area of industrial minerals, one of North Carolina's two lithium operations was for sale, and work continued on a new mica mine and plant. Three granite producers complained to the U.S. International Trade Commission (ITC) that foreign firms were selling stone in the United States below production costs.

Table 1.—Nonfuel mineral production in North Carolina[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---- thousand short tons	2,688	$10,477	2,658	$10,970	3,229	$15,282
Feldspar ---- short tons	490,993	13,351	526,672	15,568	512,386	15,562
Gem stones	NA	e50	NA	551	NA	550
Gold (recoverable content of ores, etc.) troy ounces	--	--	12	4	--	--
Mica (scrap) ---- thousand short tons	80	3,726	89	4,641	100	5,607
Peat ---- do	W	W	15	W	W	W
Sand and gravel:						
Construction ---- do	e6,100	e19,500	7,543	23,127	e8,600	e30,100
Industrial ---- do	1,294	13,086	1,464	16,656	1,184	15,329
Stone:						
Crushed ---- do	41,771	194,818	e43,500	e206,500	48,847	237,181
Dimension ---- do	35	6,132	e41	e6,633	33	5,128
Talc and pyrophyllite ---- do	85	1,604	83	1,552	W	W
Combined value of lithium minerals, olivine, phosphate rock, and values indicated by symbol W	XX	r203,442	XX	r180,528	XX	152,178
Total	XX	r466,186	XX	466,730	XX	476,917

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in North Carolina in 1986, by county[1]

County	Minerals produced in order of value
Alamance	Clays.
Anson	Sand (Industrial).
Avery	Mica, clays.
Beaufort	Phosphate rock, sand and gravel.
Bertie	Sand and gravel.
Bladen	Do.
Brunswick	Do.
Buncombe	Do.
Burke	Do.
Cabarrus	Clays, sand and gravel.
Caldwell	Sand and gravel.
Camden	Do.
Carteret	Do.
Catawba	Do.
Chatham	Clays.
Chowan	Sand and gravel.
Cleveland	Lithium, mica, sand and gravel, clays, feldspar.
Craven	Sand and gravel.
Cumberland	Do.
Dare	Do.
Davidson	Clays.
Davie	Sand and gravel.
Duplin	Do.
Durham	Clays.
Edgecombe	Sand and gravel.
Franklin	Do.
Gaston	Mica, feldspar, lithium.
Guilford	Clays, sand and gravel.
Halifax	Clays.
Harnett	Sand and gravel (industrial), clays.
Henderson	Clays.
Hertford	Sand and gravel.
Hoke	Do.
Hyde	Peat, sand and gravel.
Iredell	Clays.
Jackson	Olivine.
Johnston	Sand and gravel.
Lee	Clays, sand and gravel.
Lenoir	Sand and gravel.
McDowell	Do.
Macon	Do.
Martin	Do.
Mitchell	Feldspar, mica, sand and gravel.
Montgomery	Sand and gravel, clays.
Moore	Pyrophyllite, sand and gravel, clays.
Nash	Sand and gravel.
New Hanover	Do.
Northampton	Do.
Onslow	Do.
Orange	Pyrophyllite.
Pasquotank	Sand and gravel.
Pender	Do.
Pitt	Do.
Richmond	Sand (industrial).
Rockingham	Clays, sand and gravel.
Rowan	Clays.
Rutherford	Sand and gravel.
Sampson	Clays, sand and gravel.
Scotland	Sand and gravel.
Stanly	Clays, old.
Stokes	Sand and gravel, clays.
Surry	Sand and gravel.
Tyrrell	Do.
Union	Clays.
Washington	Sand and gravel.
Watauga	Do.
Wayne	Do.
Wilkes	Do.
Wilson	Do.
Yadkin	Do.
Yancey	Olivine, sand and gravel, mica.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Trends and Developments.—During the 1980's (1980-87), North Carolina's mineral value increased over $97 million, and by 1987 was approaching the one-half billion-dollar level. Only during the recession of the early 1980's did year-to-year value fall, and by 1983 mineral sales had regained their upward climb, exceeding the 1980 level by $18 million.

For the past several years North Carolina's mineral value has been derived entirely from the extraction and processing of industrial minerals. However, in 1987 the prospect of an extractive metals industry appeared as a distinct possibility as four companies conducted exploration programs for gold in Davidson, Moore, Randolph, and Union Counties. An Oregon company applied for permits for a proposed titanium plant in eastern North Carolina.

In the industrial minerals sector, Newmont Mining Corp. was seeking a buyer for Foote Mineral Co., the large domestic lithium producer with a mine, mill, and chemical plant at Kings Mountain. J. M. Huber Corp. began work on a dry ground-mica plant at Kings Mountain. The plant and adjacent mine were scheduled for operation in mid-1988.

Exploration Activities.—Niagara Capital Company continued exploration and beneficiation studies for gold and other metals at the old Silver Hill Mine in Davidson County. Unconfirmed preliminary news releases reported 144,000 short tons of reserves grading 0.15 troy ounces of gold per ton, 1.49 troy ounces of silver per ton, and a combined grade of 19.4% lead-zinc per ton.[3]

Adena Minerals Co. filed an application with the State Department of Natural Resources and Community Development to develop a 125-acre gold property in Moore County near Robbins. The company would employ a heap-leach process utilizing sodium cyanide to recover the gold from a low-grade ore.

Carolina Gold Resources continued exploration work at the old Allred gold mine near Grays Chapel in Randolph County, and Cominco American was conducting exploration work at the old Howie Mine near Waxhaw.

Legislation and Government Programs.—A bill (Senate bill 486) that would levy a severance tax on the mining of phosphate rock was introduced in the North Carolina Senate. The tax would be $2.23 per short ton. The bill was still in the Finance Committee when the legislature adjourned in August.

In October a joint North Carolina-Virginia committee was formed to study a plan to pump water from the Texasgulf Chemical Co. mine at Aurora to northeastern North Carolina and southeastern Virginia. Approximately 46 million gallons of water per day was discharged from the Aurora phosphate operation into the Pamlico River.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

The value of industrial mineral production in North Carolina increased $10.2 million over that reported by producers in 1986.

Clays.—North Carolina ranked second among the 44 clay producing States, and the value of clay production was 3% of the total mineral output. North Carolina's clay producers mined 3.2 million short tons of clay valued at $15.3 million, a new record.

North Carolina's clay industry consisted of 35 companies operating 48 pits in 22 of the State's 100 counties. Common clay was produced at 46 of the pits, and 2 produced kaolin recovered as a coproduct with mica production. Primary uses of the common clays were for the manufacture of brick and other structural clay products; kaolin sales, in descending order of value, were for insulators, ceramics, and specialty brick manufacture.

Feldspar.—North Carolina feldspar production accounted for 71% of the Nation's total; however, output decreased 14,300 short tons from 1986. Compared with 1986, fewer housing starts in the market area for North Carolina feldspar resulted in reduced demand for feldspar in the manufacture of plumbing fixtures, tile, and glass fiber insulation.

Three companies mined alaskite, an ore that contains approximately 65% feldspar, and recovered a feldspar concentrate by flotation. Two companies recovered a feldspar-silica concentrate during lithium beneficiation, and a third recovered a feldspar concentrate as a byproduct of mica beneficiation. Shipments of marketable feldspar by U.S. producers to North Carolina increased from 20,700 short tons in 1986 to 40,500 short tons in 1987.

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Lithium.—North Carolina's lithium production declined because Foote produced at a fraction of its capacity. Foote closed its Kings Mountain lithium chemical plant in May, 1986. The closure was due to lower operating costs at company plants in Nevada and Chile, as well as a lower-than-expected growth in lithium demand. At yearend, negotiations were under way with Cyprus Minerals Co. to buy Foote from Newmont Mining.

Lithium Corp. of America Inc. (Lithco) continued as the State's dominant lithium producer. Lithico's mine and plant were located near Cherryville in the Kings Mountain area. The company mined a spodumene-bearing pegmatite by open pit methods and produced a spodumene concentrate by flotation, which was used in the manufacture of lithium chemicals which, in turn, were sold on the open market, primarily to the aluminum, glass, and grease industries.

Mica.—In 1987, mica production in North Carolina accounted for 68% of the value and 62% of the tonnage produced in the United States. Production was greater than in 1986, primarily due to the strong construction sector and the demand for mica in joint compound and paint. Three companies, Deneen Mica Co., KMG Minerals Inc., and Unimin Corp., produced mica as a primary commodity; the three feldspar companies produced mica as a byproduct.

J. M. Huber Corp. broke ground in May for a 20,000-square-foot processing plant to recover moscovite mica from ore that would be mined on adjacent property. The $3.4 million plant was scheduled for completion in mid-1988.

Olivine.—Unimin Inc. operated the only olivine mine and plant in North Carolina. The plant wet ground olivine for sales to the foundry industry. Foreign competition had forced the closing of two of the State's olivine mines.

Phosphate Rock.—North Carolina continued to rank second nationally in the production of phosphate rock. Texasgulf Chemical Co. operated a mining, beneficiation, and phosphoric acid manufacturing complex at Lee Creek in Beaufort County. Dredges and draglines stripped the overburden. Draglines mined the ore, which was slurried to a flotation plant to produce a phosphate rock concentrate for phosphoric acid. The world's largest sulfuric acid plant was
housed at the complex.

During the year, several bucket-wheel excavators were erected to replace the dredges in stripping the upper portion of overburden. The excavators were obtained when Texasgulf purchased North Carolina Phosphate Corp.

In 1987, a bill was submitted to the North Carolina Legislature which, if enacted, would have placed a $2.23-per-short-ton-severance tax on phosphate mined instate. The bill was defeated. At yearend, the company and the State were negotiating a new water-discharge permit. Under terms of the permit, Texasgulf would recycle all contaminated water that previously was discharged into the Pamlico River.

Pyrophyllite.—In 1987, North Carolina led the Nation in pyrophyllite output. Three companies, Standard Minerals Co. Inc. and Glendon Pyrophyllite Inc. in Moore County and Piedmont Minerals Co. in Orange County, operated four surface mines and three beneficiation plants. The product was used as an insecticide filler and carrier, wallboard and latex foam filler, and refractory material.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates. Approximately 50% of North Carolina's construction sand and gravel was mined from 4 areas in 10 counties. These included, in descending order of tonnage, Cumberland and Harnett Counties; Anson, Montgomery, and Richmond Counties; Buncombe, McDowell, and Yancey Counties; and Cabarrus County. Production reached a record high because of the demand for aggregate in the construction industry.

Industrial.—In 1978, production of industrial sand and gravel was reported to the Bureau of Mines by seven companies operating seven mines in five counties. Over 80% of the production was from the Anson-Richmond contiguous county area. Mines in Cleveland, Harnett, and Mitchell Counties supplied the remainder. More than 50% of the sales were to the flat and container glass industries; other reported uses, in descending tonnages, were for the manufacture of ferrosilicon, filtration uses, sandblasting, and traction sand.

The Feldspar Corp. completed construction of its high-purity quartz facility near Spruce Pine. Plant feed is quartz obtained during the beneficiation of alaskite, a feldspar ore. Unimin Inc. operated a similar plant in the Spruce Pine area.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for

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1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Throughout the year, the crushed stone industry continued to experience citizen opposition to the opening of new quarries. During 1987, state-local permits and/or rezoning actions were sought for 12 new quarries. The necessary rezoning was obtained by 1 company in the Bessemer City area; the other 11 had not been approved at yearend.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three North Carolina districts depicted in figure 1.

Table 3.—North Carolina: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	587	3,221
Filter stone	171	747
Coarse aggregate, graded:		
Concrete aggregate, coarse	5,973	31,112
Bituminous aggregate, coarse	2,906	15,852
Bituminous surface-treatment aggregate	967	4,733
Railroad ballast	1,723	7,325
Fine aggregate (-3/8 inch):		
Stone sand (concrete)	578	2,760
Stone sand, bituminous mix or seal	442	2,003
Screening, undesignated	1,902	8,157
Coarse and fine aggregates:		
Graded road base or subbase	12,525	54,805
Unpaved road surfacing	213	974
Crusher run or fill or waste	12,446	64,457
Other construction[2]	2,225	11,922
Other miscellanous[3]	1,512	7,956
Other unspecified[4]	4,675	21,156
Total[5]	48,847	237,181

[1]Includes granite, limestone, traprock, slate, volcanic cinder and scoria, quartzite, and marl.
[2]Includes macadam, and terrazzo and exposed aggregate.
[3]Includes agricultural limestone, other agricultural uses, and flux stone.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown becaused of independent rounding.

Table 4.—North Carolina: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	158	866	219	1,471	398	1,731
Coarse aggregate, graded[2]	1,946	8,983	5,031	26,853	4,593	23,187
Fine aggregate (-3/8 inch)[3]	608	2,528	960	4,115	1,354	6,279
Coarse and fine aggregates[4]	2,876	11,830	13,481	64,573	9,105	45,384
Other construction	146	814	1,641	8,797	143	660
Agricultural[5]	--	--	--	--	W	W
Chemical and metallurgical[6]	--	--	W	W	--	--
Other miscellaneous	24	98	1,470	7,759	18	99
Other unspecified[7]	1,787	7,380	1,509	5,594	1,379	8,183
Total[8]	7,546	32,498	24,311	119,161	16,990	85,522

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screening, undesignated).
[4]Include graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill waste.
[5]Includes agricultural limestone and other agricultural uses.
[6]Includes flux stone.
[7]Includes production reported without a breakdown by end use and estimates for nonrepondents.
[8]Data may not add to totals shown because of independent rounding.

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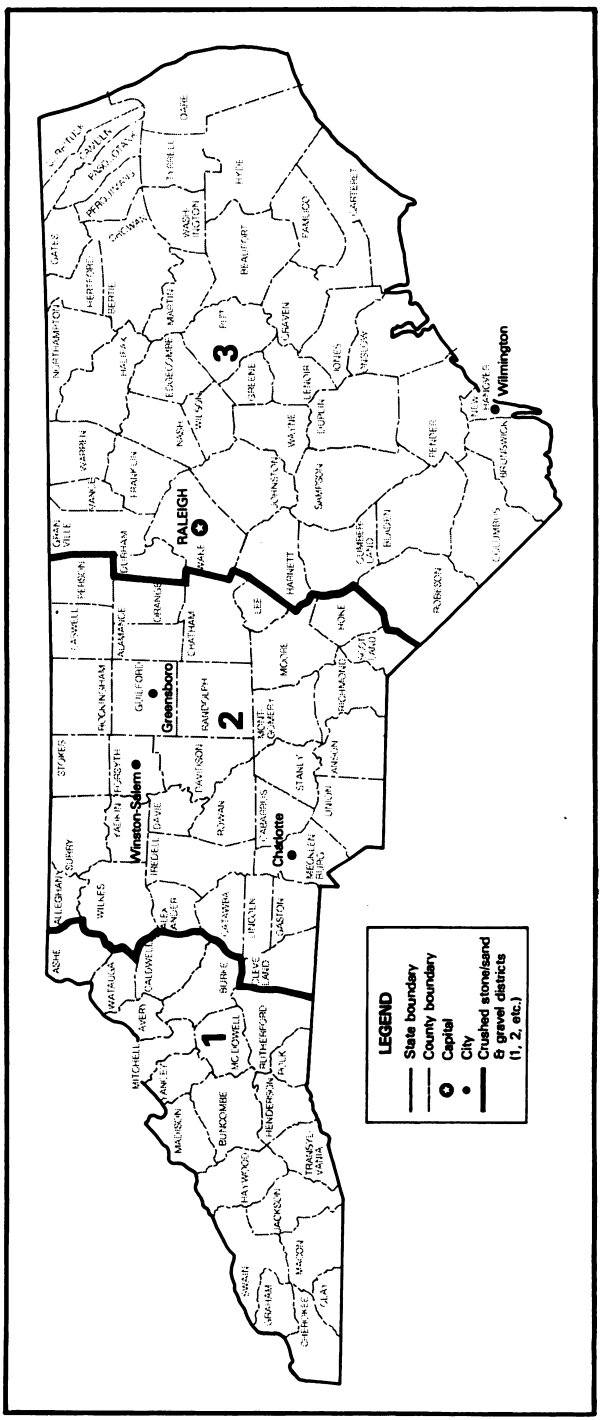

Figure 1.—Aggregate-producing districts in North Carolina.

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Dimension.—North Carolina ranked seventh out of 36 States in the quarrying of dimension stone. Granite was quarried by five companies; sandstone, argillite and marble by one each.

The North Carolina Granite Corp., operator of the world's largest open-pit granite quarry, and two other domestic producers joined in seeking trade sanctions against Spanish and Italian granite producers. The foreign companies were accused of selling, with the help of government subsidies, granite in the United States below the foreign companies' production costs. The U.S. companies requested that ITC levy tariffs preliminarily on granite imports.

Other Industrial Minerals.—The State ranked high in the eastern United States in the number of mines and businesses producing or selling gem stones and mineral specimens. Principal gem-collecting counties, all in the western part of the State, were Alexander (emeralds and hiddenite), Macon (rubies, sapphires and garnets), and Mitchell (emeralds and aquamarine). Two companies, Great Lakes Carbon Corp. at Morganton and Morganite Inc. at Dunn, manufactured a variety of products from synthetic graphite. National Gypsum Co. imported crude gypsum from Canada for use in wallboard manufacturing at a plant in Wilmington. Texasgulf Inc. produced a byproduct gypsum during phosphoric acid manufacture at its fertilizer complex at Lee Creek. A small smount was sold as a soil conditioner; however, much of the output was mixed with clay and pumped back into the mined-out phosphate pits. Byproduct slag was produced as a waste product by the Florida Steel Corp.'s plant in Charlotte. The slag was marketed for use as an aggregate. The Warner Corp. in Murphy manufactured talc crayons for the steel industry from crude talc imported from China. The company closed its underground talc mine in December 1986, because of high production costs as compared to talc imported from developing countries.

METALS

Metal mining in North Carolina terminated in 1971 when the Tungsten Queen Mine near Townsville in Vance County closed. In 1987 a variety of metallic ores or semiprocessed products were shipped into North Carolina for processing into a higher value, finished product.

Commodity	Company	Location	Remarks
Aluminum	Aluminum Co. of America	Badin	115,000-metric-ton-per-year smelter.
Chromium	Occidental Chemical Corp	Castle Hayne	1 of 2 primary chromium chemical plants in the United States.
Cobalt	Carolmet Inc	Laurenburg	Only powdered cobalt plant in the United States.
Copper	SCM Co., Glidden Metals Div.	Durham	Powdered copper.
Lithium	Lithium Corp. of America Inc.	Cherryville	Lithium metal.
Silver	E. I. du Pont de Nemours & Co.	Arden	Silver emulsions separated from film waste.
Steel	Nucor Corp	Charlotte	Two 35-ton furnace minimill.

Aluminum Co. of America restarted an idled half-potline in June at the company's aluminum smelter at Badin. Albany Titanium Inc., an Oregon company, applied for State permits for a proposed titanium plant on Texasgulf Chemical Co. property in eastern North Carolina. The plant would process ilmenite shipped from Florida by barge.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

[2]Geologist, North Carolina Geological Survey Section, Raleigh, NC.

[3]World Investment News. New Life for Historic Mine. June 1987, p. 19

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Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum, smelter:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Stanly.
Clays:			
Hammill Construction Co	Route 2, Box 33H Gold Hill, NC 28071	Surface mines and plant.	Cabarrus and Rowan.
Pine Hall Brick & Pipe Co	Box 11044 Winston-Salem, NC 27105	do	Rockingham and Stokes.
Virginia Solite Corp	Box 27211 Richmond, VA 23261	do	Rockingham and Stanly.
Feldspar:			
The Feldspar Corp.[1]	Box 99 Spruce Pine, NC 28777	do	Mitchell.
Indusmin Inc.[1]	Box 309 Spruce Pine, NC 28777	do	Do.
Unimin Corp.[1]	Box 628 Spruce Pine, NC 28777	do	Do.
Lithium:			
Foote Mineral Co.[2]	Box 792 Kings Mountain, NC 28086	Surface mine and plant.	Cleveland.
Lithium Corp. of America Inc.[1 2]	449 North Cox Rd. Gastonia, NC 28052	do	Gaston.
Mica:			
Deneen Mica Co	Box 28 Micaville, NC 28755	Surface mines	Yancey.
Unimin Corp.[3]	Box 628 Spruce Pine, NC 28777	do	Avery.
KMG Minerals Inc.[2]	Box 729 Kings Mountain, NC 28086	Surface	Cleveland.
Olivine:			
AIMCOR	Box 672 Spruce Pine, NC 28777	do	Jackson and Yancey.
Perlite (expanded):			
Carolina Perlite Co. Inc	Box 741 Hillside, NJ 07205	Plant	Rowan.
Phosphate rock:			
Texasgulf Inc.[4]	Box 48 Aurora, NC 27806	Surface mine and plant.	Beaufort.
Pyrophyllite:			
Glendon Pyrophyllite Inc	Box 306 Carthage, NC 28327	Surface mines and plant.	Alamance and Moore.
Piedmont Minerals Co.[5]	Box 7247 Greensboro, NC 27407	Surface mine and plant.	Orange.
Standard Minerals Co. Inc	Box 278 Robbins, NC 27325	do	Moore.
Sand and gravel (construction):			
Becker Sand & Gravel Co	Box 698 Lillington, NC 27546	Pits	Anson and Harnett.
W. R. Bonsal Co	Box 38 Lilesville, NC 28091	do	Anson.
B. V. Hedrick Gravel and Sand Co.[1]	Box 8 Lilesville, NC 28091	do	Buncombe.
Stone:			
Martin Marietta Corp	Box 30013 Raleigh, NC 27622	do	Various.
Nello L. Teer Co	Box 1131 Durham, NC 27702	do	Do.
Vulcan Materials Co., Mideast Div.	Box 7497 Winston-Salem, NC 27109	do	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Guilford.

[1]Also mica.
[2]Also feldspar.
[3]Also clays.
[4]Also byproduct gypsum.
[5]Also sericite.

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The Mineral Industry of North Dakota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the North Dakota Geological Survey for collecting information on all nonfuel minerals.

By Leon E. Esparza[1]

The value of North Dakota's nonfuel mineral production was $26.3 million, an increase of about 26% compared with 1986 figures. The State ranked 48th nationally in nonfuel mineral production, accounting for less than 1% of the U.S. total. Lime contributed the greatest amount to the State's nonfuel mineral value, accounting for 45% of the total. Other commodities produced, in order of decreasing value, included construction sand and gravel, salt, crushed stone, clays, industrial sand and gravel, and gem stones. Peat was sold from stockpiled material, and elemental sulfur was recovered from processing natural gas.

Most of the State's nonfuel mineral production was used in construction. A total of 1,970 residental units were authorized in 1987, a 16% increase over the number issued in 1986. Valuation of nonresidential construction in 1987 was $88.7 million, a 10% increase over that of 1986. However, value of State road contract awards fell 7% to $94.0 million.

Employment.—Average annual employment in the nonfuel minerals industry during 1987 was 400, an 8% increase over that reported for 1986.

Table 1.—Nonfuel mineral production in North Dakota[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	W	W	W	W	50	$100
Gem stones	NA	e$2	NA	$2	NA	2
Lime ---------- thousand short tons	56	5,562	74	7,359	127	11,912
Sand and gravel (construction) ---- do----	e6,900	e13,800	5,135	10,741	e4,900	e10,200
Combined value of peat, salt, sand and gravel (industrial), stone (crushed miscellaneous), and values indicated by symbol W	XX	4,820	XX	2,700	XX	4,097
Total ----------	XX	24,184	XX	20,802	XX	26,311

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in North Dakota in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel (construction).
Barnes	Do.
Benson	Do.
Billings	Do.
Bottineau	Peat.
Bowman	Salt, sand and gravel (construction).
Burke	Sand and gravel (construction).
Burleigh	Do.
Cass	Do.
Dickey	Do.
Eddy	Do.
Foster	Do.
Grand Forks	Do.
Grant	Sand (industrial).
Hettinger	Sand and gravel (construction).
Kidder	Do.
Logan	Do.
McIntosh	Do.
McLean	Do.
Morton	Clays, sand and gravel (construction).
Pembina	Lime.
Pierce	Sand and gravel (construction).
Ramsey	Do.
Ransom	Do.
Renville	Do.
Richland	Lime, sand and gravel (construction).
Rolette	Sand and gravel (construction).
Sheridan	Do.
Stark	Do.
Stutsman	Do.
Towner	Do.
Traill	Lime, sand and gravel (construction).
Walsh	Sand and gravel (construction).
Ward	Do.
Wells	Do.
Williams	Salt, sand and gravel (construction).
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Clays.—Clay production and value decreased from those reported in 1986. Hebron Brick Co. in Morton County was the sole producer in the State.

Lime.—Production and value of lime increased 72% and 62%, respectively, in 1987 over those reported in 1986. Most of the production was used to process sugar beets during a longer refining season than normal for the second consecutive year.

Peat.—Peat Products Co., Bottineau County, sold stockpiled peat and posted a moderate increase in value of sales for 1987.

Salt.—Salt production and value in 1987 increased over those reported in 1986. A sale of the Diamond Crystal Salt Co. was near completion by yearend. International Salt Co., a subsidiary of Akzo NV, a Dutch chemical corporation, reportedly was to purchase Diamond Crystal for $65 million.[3]

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Operations in North Dakota and three other States would be included in the transaction.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Production and value were estimated to have decreased about 5% in 1987 compared with 1986 figures.

Stone (Crushed).—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

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[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.

[2]Daily Herald (Williston, ND). Diamond Crystal Has a Definitive Sale Agreement. Sept. 18, 1987.

Table 3.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Hebron Brick Co	Box 5 Washington Ave. East Hebron, ND 58638	Pit and plant	Morton.
Lime:			
American Crystal Sugar Co	Box 190 Drayton, ND 58225	Shaft kilns at beet sugar refineries.	Pembina and Traill.
Minn-Dak Farmers Co-op	Wahpeton, ND 58075	do	Richland.
Peat:			
Peat Products Co	821 4th St. Bismarck, ND 58501	Bog	Bottineau.
Salt:			
Diamond Crystal Salt Co	916 South Riverside St. Clair, MI 48640	Solids and evaporated brines.	Williams.
Sand and gravel:			
Construction (1986):			
Badinger Sand & Gravel Co	Box 306 Dickinson, ND 58601	Pits and plants	Stark.
Bradshaw Gravel Supply Inc	Box 1677 Grand Forks, ND 58206	do	Grand Forks, Rolette, Walsh.
Des Lacs Sand & Gravel Co	Box 66 Des Lacs, ND 58733	do	Various.
Fisher Sand & Gravel Co	Box 1034 Dickinson, ND 58601	do	Do.
Northern Improvement Co	Box 1254 Bismarck, ND 58501	do	Burleigh.
Schriock Construction Inc	3009 South Broadway Minot, ND 58701	do	Various.
Industrial:			
Dakota Silica Inc.	Box 233 Elgin, ND 58533	Pit and plant	Grant.
Stone (crushed):			
Helm Bros. Inc	Box 787 Mandan, ND 58554	Pit	Mercer.
The North American Coal Corp	Box 299 Beulah, ND 58523	Pits	Do.
Sulfur (recovered):			
Chevron USA Inc	Box 1589 Tulsa, OK 74101	Plant	Billings.
Koch Hydrocarbon Co	Box 2256 Wichita, KS 67201	Plants	McKenzie and Williams.
Phillips Petroleum Co	1140 Adams Bartlesville, OK 74004	Plant	Williams.
Western Gas Processors Ltd	10701 Melody Dr. Northglenn, CO 80234	do	Billings.

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The Mineral Industry of Ohio

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Ohio in 1987 was about $769 million; the highest total reported in State history. Ohio ranked 11th in the Nation in the value of nonfuel mineral production, accounting for almost 3% of the U.S. total value. The State was among the top five in production of common clay, fire clay, lime, salt, and construction sand and gravel. Ohio also ranked second in the United States in steel manufacturing, as well as among the Nation's top 10 producers of coal.

Table 1.—Nonfuel mineral production in Ohio[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons	110	$10,412	138	$11,540	139	$11,964
Portland ----------do----	1,769	84,929	1,706	79,383	1,748	83,661
Clays ----------do----	2,114	10,581	2,833	11,515	3,187	12,714
Gem stones ----------	NA	e10	NA	10	NA	10
Lime ---------- thousand short tons	1,730	84,142	1,648	81,103	1,926	93,108
Peat ----------do----	16	413	6	W	W	W
Salt ----------do----	4,329	130,964	4,115	126,757	3,276	104,099
Sand and gravel:						
Construction----------do----	e33,000	e109,000	36,806	126,747	e36,400	e136,900
Industrial ----------do----	1,312	21,945	1,221	21,183	1,249	21,292
Stone:						
Crushed----------do----	38,310	136,544	e39,300	e147,300	51,590	300,096
Dimension ----------do----	53	3,661	e36	e2,708	48	2,427
Combined value of abrasives, gypsum, and values indicated by symbol W ----------	XX	1,541	XX	1,738	XX	2,510
Total ----------	XX	594,142	XX	609,984	XX	768,781

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Ohio in 1986, by county[1]

County	Minerals produced in order of value
Allen	Sand and gravel.
Ashland	Do.
Ashtabula	Lime, sand and gravel.
Athens	Sand and gravel.
Auglaize	Sand and gravel, clays.
Belmont	Sand and gravel.
Brown	Do.
Butler	Do.
Carroll	Do.
Champaign	Sand and gravel, peat.
Clark	Sand and gravel.
Clermont	Do.
Columbiana	Sand and gravel, clays.
Coshocton	Do.
Crawford	Sand and gravel.
Cuyahoga	Salt, clays, peat.
Darke	Sand and gravel.
Darke	Sand and gravel.
Defiance	Do.
Erie	Lime, sand (industrial).
Fairffield	Sand and gravel.
Franklin	Sand and gravel, clays.
Gallia	Sand (industrial).
Geauga	Do.
Greene	Cement, sand and gravel, clays.
Hamilton	Sand and gravel.
Harrison	Clays.
Henry	Sand and gravel.
Hocking	Sand and gravel, clays.
Holmes	Clays, sand and gravel.
Jackson	Clays.
Knox	Sand (industrial).
Lake	Salt, lime, sand and gravel.
Lawrence	Cement, clays, sand and gravel.
Licking	Sand and gravel, clays.
Logan	Sand and gravel.
Lorain	Do.
Lucas	Sand and gravel, cement, clays.
Mahoning	Sand and gravel.
Marion	Sand and gravel, clays.
Medina	Do.
Meigs	Sand and gravel.
Miami	Do.
Montgomery	Do.
Morgan	Do.
Morrow	Do.
Muskingum	Cement, sand and gravel, clays.
Ottawa	Lime, gypsum.
Paulding	Cement, clays.
Perry	Sand (industrial), clays.
Pickaway	Sand and gravel.
Pike	Do.
Portage	Do.
Preble	Do.
Richland	Do.
Ross	Sand (industrial).
Sandusky	Lime.
Scioto	Sand and gravel.
Seneca	Clays.
Shelby	Sand and gravel.
Stark	Sand and gravel, cement, clays.
Summit	Salt, sand and gravel.
Trumbull	Sand and gravel.
Tuscarawas	Clays, sand (industrial).
Warren	Sand and gravel.
Washington	Do.
Wayne	Salt, sand and gravel.
Williams	Sand and gravel, peat.
Wyandot	Sand and gravel, clays, peat.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Trends and Developments.—Mining and mineral-related industries in Ohio reported production valued at $5.2 billion in 1987. Output of mineral commodities processed or manufactured in the State including aluminum, ferroalloys, synthetic graphite, calcined gypsum, pig iron, iron and steel slag, recovered sulfur, and exfoliated vermiculite was valued at $2.8 billion; pig iron shipments accounted for 75% of the total. Production of coal, oil, and gas generated $1.6 billion in value; coal accounted for about 65% of the total.

Nonfuel minerals listed in table 1, valued at $769 million, accounted for a lower value than the fuel or manufactured commodities primarily because of lower unit prices. However, production of nonfuel minerals in Ohio increased significantly during the previous 4 years, whereas the output of most fuels and manufactured minerals remained about the same or improved only slightly, as shown below:

Commodity		1983	1987	1983-87 percent change
Nonfuels:				
Clays	thousand short tons	1,716	3,187	+86
Crushed stone	do.	32,937	51,590	+57
Sand and gravel	do.	27,200	36,400	+34
Fuels:				
Coal	thousand short tons	33,217	33,152	--
Oil	thousand barrels	14,917	12,153	-19
Manufactured minerals:				
Ferroalloys	thousands short tons	W	W	-4
Pig Iron	do.	[1]9,314	[1]10,297	+11

W Withheld to avoid disclosing company proprietary data.
[1]Shipments.

The change in production levels is even greater in comparison with 1970, when Ohio produced about 47 million tons of stone, 55 million tons of coal, and 16.3 million tons of pig iron. Nonfuel minerals were expected to become an even more significant part of the State's mining and mineral-production sector because of strong demand for nonfuel minerals used in construction.

Producers of manufactured and processed minerals as well as fuels, in particular coal, were expected to face increased regulation because of environmental concerns. Indications were that industry would gain little relief from environmental regulations and their associated cost for some time into the future; if anything, the trend was toward increased regulation.[2]

Nonfuel minerals, especially those produced in Ohio such as crushed stone, sand and gravel, and clays were less environmentally sensitive in regard to air, water, and mine-waste regulations. The major concern of industrial minerals producers was expected to be land-use decisions because of continuing population expansion in the suburbs where most mines, quarries, and pits are located.

Legislation and Government Programs.—The Supreme Court of Ohio upheld a lower court ruling denying Best Silica Sand Co. extension of a mining permit at an industrial sand pit in Bainbridge, Geauga County. The court noted that local and State governments are jointly responsible in regulating mining activities. However, in this case, Bainbridge Township officials issued a 10-year zoning variance that allowed mining until 1984. Best Silica received a State permit to continue mining beyond 1984, but the court found that permit invalid.

The Ohio Division of Geological Survey (DGS) was the primary State agency for mineral research and resource investigations. The 1987 DGS Report on Ohio Mineral Industries included a listing of 294 active coal and 445 industrial minerals operators, 15 and 17 operators, respectively, fewer than in 1986.[3]

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

The major nonfuel commodities identified in table 1 are discussed in this section. Crushed stone accounted for about 39% of the value of Ohio's nonfuel mineral production; construction sand and gravel, 18%; salt, 14%; lime, 12%; and portland cement, 11%. All other mineral commodities accounted for the remaining 6%.

Cement.—For the third consecutive year, Ohio produced more that 1.7 million short tons of portland cement. Its production trends for the previous 5 years were similar to those throughout the Nation. Both Ohio and U.S. output increased by about 11% from 1983 to 1987. Ohio's cement industry was 100% domestically owned; nationally, approximately 55% of U.S. cement production capacity had been acquired by foreign owners by yearend. In 1987, Ohio's five cement plants operated at 70% of production capacity, about 4% below the U.S. average rate.

Lime.—Ohio remained the Nation's leading producer of lime in 1987. Production increased for the first time in 3 years as a result of improved conditions in the steel industry and increased demand for lime used in abatement of pollution.

Ohio Lime Co., a subsidiary of Steetley Resources Inc., received approval from the Ohio Environmental Protection Agency to test burn solvent-derived fuel. Ohio Lime planned to mix the byproduct solvent waste fuel with coal to lower energy costs in manufacturing lime. Monitoring of the test burn was required to ensure no toxic chemicals were emitted into the atmosphere during combustion. A decision on allowing Ohio Lime to burn the waste fuel on a regular basis was expected in 1988 after results of the monitoring were analyzed.

Salt.—Ohio ranked third nationally, accounting for 9% of the U.S. production of salt. Output declined by almost 20% in 1987 primarily because of milder winter conditions, which resulted in lower demand for salt to melt ice and snow. During the year, International Salt Co., a subsidiary of Akzo NV, a Dutch corporation, purchased Diamond Crystal Salt Co., which produced salt from a well in Summit County.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction Aggregates.—Approximately 70% of the 88 million short tons of construction sand and gravel and crushed stone produced in Ohio was used in construction. Since 1979, when the State reported a combined production of sand and gravel and stone of about 97 million tons, output paralleled conditions in the construction industry. Production declined by nearly 20 million tons in 1980 and dropped to 56 million tons by 1982 as high interest rates had an adverse impact on construction. As interest rates began to drop in 1983 and Federal legislation was enacted to provide funding for highway construction through a gasoline tax, aggregate production began a 5-year period of continual growth. Housing starts, one indicator of construction industry demand, increased from 16,600 in 1982 to 44,500 in 1987. A 10-year, $1.2 billion State bond issue also provided funding to counties and municipalities to improve Ohio's infrastructure and spurred road construction projects throughout the State.

A major issue in the aggregate industry continued to be the availability of land to mine. A number of aggregate deposits in Akron, Canton, Cincinnati, Columbus, and Dayton, along with other areas, were used for building purposes or were closed to mining by zoning. Ohio's highly populated cities were the same areas in which demand for construction aggregates was the greatest. Because aggregate is a bulk commodity, haul distance is typically a major component of the price. According to the Ohio Aggregates Association, the cost of mineral aggregate produced in southern Columbus was double by the time it was deliverod to northern Columbus.

In addition, tax revenues were used to purchase more than one-half of all the aggregate sold in Ohio. State, county, township, and municipal governments indirectly purchased large quantities of aggregate through contract construction for road maintenance and building projects. Federal funding was usually included in public works programs involving airports, dams, locks, erosion control, and waste-treatment facilities. Thus, indiscriminate zoning or land-use decisions that eliminate the possibility of developing an aggregate deposit

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resulted in higher taxes.

Ohio began to address this issue by developing criteria for "critical mineral resource" zoning. In 1987, R. W. Sidley Inc. succeeded in having a silica deposit in Geauga County declared a critical mineral resource by the local zoning authority. This action was believed to be a first in Ohio and was expected to provide protection to the company from nonmining encroachment until the deposit was mined to depletion.[4]

Also during the year, American Aggregates Corp., one of Ohio's leading aggregate producers was purchased by ARC America Corp., a subsidiary of Consolidated Gold Fields PLC of the United Kingdom. American Aggregates operated 10 stone quarries and 12 sand and gravel pits in the State and owned significant reserves.

The DGS continued county sand and gravel resource studies that provide resource tonnage estimates by township, pebble counts, and sieve analysis. In 1987, reports were published for the counties of Bulter, Champaign, Clark, and Columbiana.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered year only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates. In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the six Ohio districts depicted in figure 1.

Table 3.—Ohio: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	4,407	14,520
Riprap and jetty stone	469	2,095
Filter stone	381	1,077
Coarse aggregate, graded:		
Concrete aggregate, coarse	2,843	10,110
Bituminous aggregate, coarse	1,514	5,402
Bituminous surface-treatment aggregate	521	2,811
Railroad ballast	580	1,939
Fine aggregate (-3/8 inch):		
Stone sand, concrete	69	239
Stone sand, bituminous mix or seal	174	651
Screening, undesignated	242	562
Coarse and fine aggregates:		
Graded road base or subbase	4,147	14,619
Unpaved road surfacing	3,538	13,681
Crusher run or fill or waste	1,401	5,009
Other construction[2]	1,123	2,761
Agricultural: Agricultura limestone	1,407	6,284
Chemical and metallurgical:		
Cement manufacture	1,538	3,913
Flux stone	1,051	6,809
Special: Other miscellaneous[3]	787	5,756
Other unspecified[4]	25,397	201,859
Total[5]	51,590	300,096

[1]Includes limestone and sandstone.
[2]Includes coarse aggregate (large).
[3]Includes poultry grit and mineral food, other agricultural uses, whiting or whiting substitute, lime manufacture, asphalt filler, and other fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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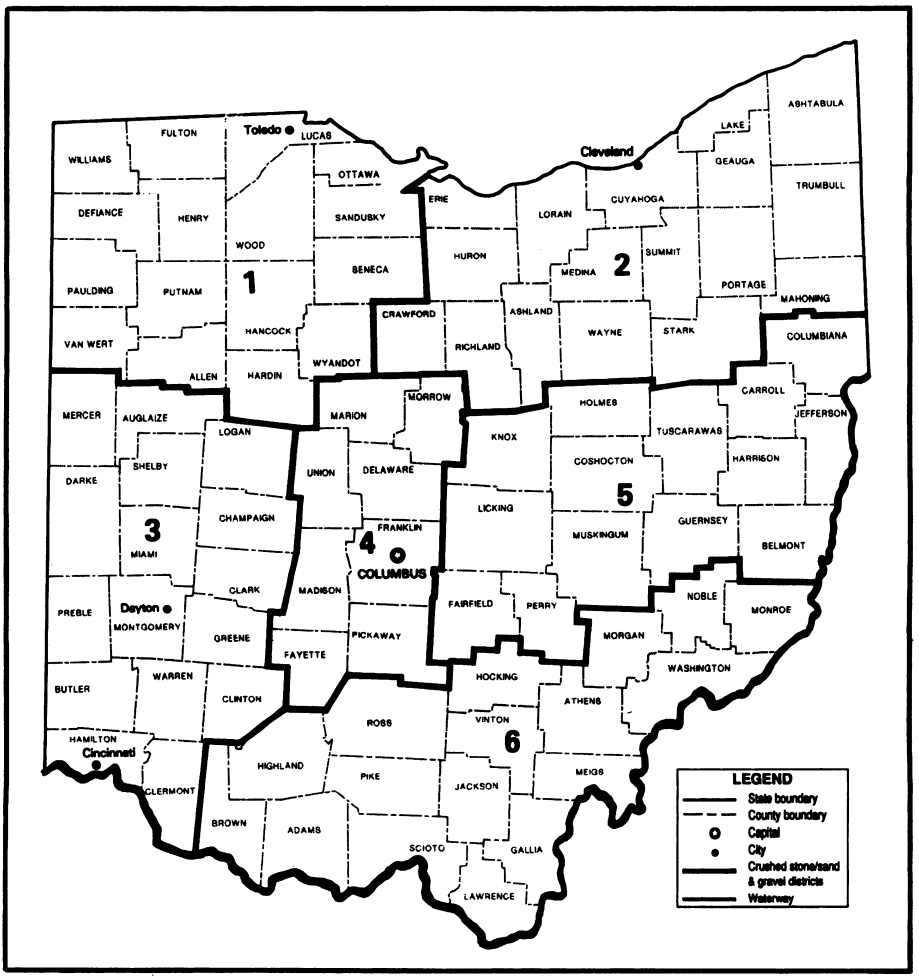

Figure 1.—Aggregate-producing districts in Ohio.

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Table 4.—Ohio: Construction sand and gravel sold or used by producers in 1986, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Course aggregate (+1-1/2 inch)[1]	2,355	6,863	893	3,121	621	1,975
Course aggregate, graded[2]	1,918	6,632	2,091	7,671	815	3,182
Fine aggregate (-3/8 inch)[3]	222	585	(4)	(4)	54	249
Coarse and fine aggregates[5]	4,399	15,758	1,571	5,959	1,180	4,490
Other construction	55	205	--	--	--	--
Agricultural[6]	733	2,916	208	799	169	1,285
Chemical and metallurgical[7]	1,701	8,129	(4)	(4)	842	2,390
Special[8]	(4)	(4)	(4)	(4)	(9)	(9)
Other miscellaneous	186	1,422	561	2,751	--	--
Other unspecified[10]	7,180	21,344	287	1,603	2,571	10,600
Total[11]	18,747	63,855	5,610	21,903	6,251	224,172

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (+1-1/2 inch)[1]	2,251	7,588	W	W	W	W
Coarse aggregate, graded[2]	330	1,403	W	W	W	W
Fine aggregate (-3/8 inch)[3]	39	141	W	W	W	W
Course and fine aggregates[5]	W	W	W	W	940	3,114
Other construction	501	1,973	724	3,097	404	1,305
Agricultural[6]	177	861	(9)	(9)	111	442
Chemical and metallurgical[7]	(9)	(9)	--	--	--	--
Special[8]	--	--	--	--	--	--
Other miscellaneous	--	--	--	--	--	--
Other unspecified[10]	7,052	25,976	3,055	17,342	5,397	126,935
Total[11]	10,349	37,932	3,779	20,439	6,853	131,796

W Withheld to avoid disclosing individual company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminious surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screen).
[4]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[5]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[6]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[7]Includes cement manufacture, lime manufacture, and flux stone.
[8]Includes asphalt filler, whiting or whiting substitute, and other fillers or extenders.
[9]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[10]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[11]Data may not add to totals shown because of independent rounding.

METALS

In this section, processed and manufactured metals are discussed. No metals are mined in Ohio.

Aluminum.—As a result of increased prices, Ohio's sole aluminum producer, Ormet Corp., was operating at full capacity of 270,000 short tons by yearend. Ormet was purchased by Ohio River Associates Inc. in late 1986.

After the sale, more than $15 million in capital investments were approved by the firm. Major modernization projects, aimed at making the Hannibal facilities competitive in the world marketplace, included a $2.3 million expenditure to automate potline operations and $6 million to upgrade casting production. These improvements were expected to lower production costs by 0.5 to 0.7 cents per pound upon completion in 1988.

Iron and Steel.—Ohio ranked second nationally in both pig iron shipments and steel production, accounting for 21% and 18%, respectively, of the U.S. total. Improved demand for iron and steel resulted in a 9% increase in pig iron shipments to 10.3 million short tons and a 12% increase in steel output to 16.2 million tons. Of the Nation's top four steelmakers, which accounted for about 50% of the domestic steel production, three had operations in Ohio.

Armco Inc. announced a 5-year, $234 million modernization program for its largest steelmaking facility in Middletown. The program included major improvements to the coke plant, recycling plant, blast furnace, slab caster, hot strip mill, cold mill, and coating and finishing operations.

LTV Steel Corp., under Federal Bankruptcy Court protection since 1986, announced intentions to sell the Warren

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works, one of its three integrated steel operations in Ohio. In 1987, about 2,300 workers were employed at the facility, which has a 1.5-million-short-ton capacity for production of flat-rolled products. A coke plant at the Warren operations was not offerod in the sale. LTV continued to operate integrated steel mills in Canton and Cleveland.

USX Corp. and the United Steelworkers of America ended a 6-month strike on February 1, 1987, agreeing to a 4-year contract that reduced wage and benefit costs by 10%. With the settlement, USX reopened its steelmaking facilities in Lorain and completed installation of a $4.25 million ladle furnace. Installation by Mannesmann Demag AG of the Federal Republic of Germany was completed in December and was expected to increase continuous casting capability at the facility from about 40% to more than 50%.

Ferroalloys.—Ohio remained the Nation's leading producer of ferroalloys. Shipments increased by 21% in 1987 primarily because of improved production and resultant demand from the steel industry.

Improved conditions in the steel industry were at least partially responsible for the purchase of two ferroalloy facilities. Globe Metallurgical Inc. in Beverly was acquired by a management group financed by Lee Capital Corp. of Boston, MA. Production of silicon metal and 50% ferrosilicon continued at the facility. Shieldalloy Corp. purchased Foote Mineral Co.'s ferrovanadium plant in Cambridge. Ferroalloy production continued at Elkem Metals Co.'s plants in Ashtabula and Marietta and Ashland Oil Co.'s facility in Columbus.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]U.S. Bureau of Mines. Issues & Needs of the Mining Industry—A Bureau of Mines Perspective. Mar. 1988, p. 3.
[3]Lopez, S. L. 1987 Report on Ohio Mineral Industries. Dep. Nat. Res., Div. of Geol. Surv., 117 pp.
[4]Mining Engineering. 1987 Annual Review. V. 40, No. 5, May 1988, p. 327.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives (natural):			
Cleveland Quarries Co.[1]	Quarry Rd. Amherst, OH 44001	Quarry and plant	Lorain.
Cement:			
Columbia Portland Cement	Box 1187 Uniontown, PA 15401	Plants	Muskingum and Stark.
General Portland Inc.[2]	Box 1019 Fort Wayne, IN 46801	Plant	Paulding.
Southwestern Portland Cement Co.[2]	Box 191 Fairborn, OH 45324	do	Greene.
Clays:			
Common:			
Belden Brick Co	Box 910 Canton, OH 44701	Pits	Tuscarawas.
Hydraulic Press Brick Co	Box 7786 Independence, OH 44131	Pit	Cuyahoga.
Fire:			
Crescent Brick Co. Inc	50 Portsmouth Rd., Box 368 Oak Hill, OH 45656	Pits	Jackson.
Gypsum:			
Crude:			
Celotex Corp.[3]	320 South Wayne Ave. Cincinnati, OH 45215	Pit and plant	Ottawa.
Calcined:			
National Gypsum Co	1901 Henderson Dr. Lorain, OH 44052	Plant	Lorain.
USG Corp	Gypsum, OH 43433	do	Ottawa.
Lime:			
Huron Lime Co	Box 451, 100 Meeker Huron, OH 44839	Quarry and plant	Erie.
Martin Marietta Corp.[4]	755 Lime Rd. Woodsville, OH 43469	do	Sandusky.
Ohio Lime Co	128 East Main St. Woodsville, OH 43469	Quarries and plants.	Do.
LTV Steel Corp	Box 6778, Room 1629 Republic Bldg. Cleveland, OH 44101	Plant	Lake.
Peat:			
Sphagnum Moss Peat Farm	9797 Thompson Rd., Route 1 West Liberty, OH 43357	Bog	Champaign.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Salt:			
International Salt Co	Box 6920 Cleveland, OH 44101	Underground mine, well, and plants.	Cuyahoga and Summit.
Morton Thiokol Inc., Morton Salt Div	Box 390 Painesville, OH 44077	Underground mine, wells, plant.	Lake and Wayne.
Sand and gravel:			
Construction:			
American Aggregates Corp.	Drawer 160, Garst Ave. Greenville, OH 45331	Pits and plants (13 operations).	Butler, Champaign, Clark, Franklin, Greene, Hamilton, Montgomery, Warren.
Dravo Corp	5253 Wooster Rd. Cincinnati, OH 45226	Pits and plants (8 operations).	Butler, Hamilton, Meigs, Warren.
Industrial:			
Best Silica Sand Co	Box 87, 11830 Ravenna Rd. Chardon, OH 44024	Quarries and mill	Geauga.
Central Silica Co	806 Market St. Zanesville, OH 43701	____do ____	Knox and Perry.
Stone:			
Crushed:			
American Aggregates Corp.[5]	Drawer 160, Garst Ave. Greenville, OH 45331	Quarries and plants.	Clark, Darke, Delaware, Fayette, Franklin, Greene, Montgomery, Warren.
The France Stone Co.[1]	8130 Brint Rd., Box 278 Sylvania, OH 43560	____do ____	Lucas, Seneca, Wood.
National Lime & Stone Co	First National Bank Bldg. Findlay, OH 45840	____do ____	Allen, Auglaize, Crawford, Delaware, Hancock, Marion, Putnam, Wyandot.
Sandusky Crushed Stone Co. Inc	Box 527 Sandusky, OH 44870	Quarry and plant	Erie.
Stoneco Inc	221 Allen St. Maumee, OH 43537	Quarries and plant	Lucas, Ottawa, Paulding, Van Wert, Wood.
Wagner Quarries Co	4203 Milan Rd. Sandusky, OH 44870	____do ____	Do.
Dimension:			
Briar Hill Stone Co	Box 148, State Route 520 Glenmont, OH 44628	____do ____	Coshocton, Holmes, Knox.
Waller Bros. Stone Quarry Co	134 County Rd. McDermont, OH 45652	____do ____	Scioto.

[1]Also dimension stone.
[2]Also common clays.
[3]Also calcined gypsum.
[4]Also crushed stone.
[5]Also sand and gravel.

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The Mineral Industry of Oklahoma

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey for collecting information on all nonfuel minerals.

By Jane P. Ohl[1] and Robert H. Arndt[2]

Nonfuel mineral production in Oklahoma was valued at $223.2 million, a 9.6% decrease from the production value of 1986. Nationally, the State ranked 34th in the value of nonfuel mineral output, accounting for less than 1% of the national total.

Construction materials represented most of the value, with crushed stone, construction and industrial sand and gravel, crude and calcined gypsum, and portland cement the leading commodities. The greatest output growth rate was reported for salt, which rose nearly 43%. The greatest decline was for masonry cement, down 18% to its lowest level since 1983.

Table 1.—Nonfuel mineral production in Oklahoma[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	43	$2,854	50	$3,198	41	$2,436
Portland do.	1,589	72,583	1,579	69,075	1,415	54,870
Clays do.	997	2,338	993	2,329	797	1,783
Gem stones	NA	e2	NA	2	NA	8
Gypsum thousand short tons	1,595	12,548	1,683	9,855	1,828	13,336
Sand and gravel:						
Construction do.	e12,600	e32,300	10,366	24,585	e10,500	e24,200
Industrial do.	W	W	1,203	16,454	1,243	17,078
Stone:						
Crushed do.	31,173	98,811	e30,900	e102,100	e25,155	e83,732
Dimension do.	11	836	e19	e913	8	861
Combined value of feldspar, iodine, lime, pumice (1985-86), salt, stone (crushed dolomite, 1987), tripoli, and value indicated by symbol W	XX	29,335	XX	18,504	XX	24,915
Total	XX	251,607	XX	247,015	XX	223,219

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Oklahoma in 1986, by county[1]

County	Minerals produced in order of value
Adair	Sand and gravel.
Atoka	Do.
Beaver	Pumice, sand and gravel.
Blaine	Gypsum, sand and gravel.
Bryan	Sand and gravel.
Caddo	Gypsum, sand and gravel.
Canadian	Sand and gravel, clays.
Carter	Sand and gravel.
Choctaw	Do.
Cleveland	Do.
Coal	Do.
Comanche	Gypsum.
Cotton	Sand and gravel.
Creek	Sand and gravel, clays.
Custer	Clays.
Garfield	Sand and gravel.
Garvin	Do.
Grady	Do.
Greer	Clays, sand and gravel.
Hughes	Sand and gravel.
Jackson	Gypsum, sand and gravel.
Jefferson	Sand and gravel.
Johnston	Do.
Kay	Do.
Kingfisher	Do.
Le Flore	Do.
Lincoln	Do.
Logan	Do.
Love	Do.
McClain	Do.
McCurtain	Do.
McIntosh	Do.
Mayes	Cement, clays, sand and gravel.
Murray	Sand and gravel.
Muskogee	Sand (industrial), feldspar, clays.
Oklahoma	Sand and gravel, clays.
Osage	Sand and gravel.
Ottawa	Sand and gravel, abrasives.
Pawnee	Sand and gravel.
Payne	Do.
Pittsburg	Do.
Pontotoc	Cement, sand and gravel, clays.
Pottawatomie	Sand and gravel.
Pushmataha	Do.
Rogers	Cement, clays.
Seminole	Sand and gravel, clays.
Sequoyah	Lime, sand and gravel.
Stephens	Sand and gravel.
Texas	Do.
Tulsa	Do.
Wagoner	Do.
Washington	Clays.
Washita	Sand and gravel.
Woods	Salt, sand and gravel.
Woodward	Iodine, sand and gravel.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—Construction activity continued sluggish into its fourth year but this trend was thought to be ending, according to the University of Oklahoma College of Business Administration.[3]

Limestone and coal were extracted simultaneously at McNabb Stone Co.'s quarry north of Tulsa, cutting production costs and extending the mine's life. A recent innovation in controlled blasting, called "alternate velocity loading," allowed workers to displace into the pit most of the shale and black slate overburden from the separate limestone and coal layers, eliminating extensive rehandling of the spoil. The McNabb Quarry, the oldest coal mine in the State, has been mined for 70 years.

Employment.—The Oklahoma Employment Security Commission reported that nonfuel mining employment in 1987 averaged 2,500 persons, down from 2,700, in 1986.

Environment.—Controversey continued to be focused on the Tar Creek cleanup site near Picher-Miami in northeastern Oklahoma, where effluents from abandoned lead, zinc, and iron mines have polluted Tar Creek and nearby streams. More than $5.5

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million in Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) money has been expended on the area since 1983, but the Oklahoma Water Resources Board claimed that pollution problems remain in Tar Creek and nearby Neosho River. The U.S. Environmental Protection Agency deemed the cleanup as complete in early 1987. Corrective measures included plugging and sealing 83 abandoned water wells and diverting surface flows around certain mine sites.[4]

By yearend, the Oklahoma Conservation Commission began the State's 50th abandoned-mine reclamation on a site in Rogers County. The commission's mine-land-reclamation program was funded by a tax of 35 cents per ton on Oklahoma-produced coal. The tax has been in effect since 1977 and is scheduled to end in 1992. When the project in Rogers County is completed in mid-1988, more than 1,500 acres of abandoned mined land in Oklahoma will have been reclaimed.

Exploration Activities.—NERCO Minerals Co. of Vancouver, WA, began exploring in southwestern Oklahoma for precious and strategic metals such as gold, platinum, and palladium. Beginning no sooner than 1988, several exploratory holes were to be drilled to about the 1,000-foot depth in Kiowa County near Tom Steed Reservoir.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—The State's portland cement production from plants in Mayes, Pontotoc, and Rogers Counties declined about 10%, a much faster rate of decline than that between 1985 and 1986. Average price per short ton was down from $43.75 in 1986 to $38.78. The total value of masonry cement produced plunged 24%, and output quantity, 18%.

Blue Circle Inc. and Lone Star Industries Inc. operated a total of five dry-process kilns, and Ideal Basic Industries Inc., two wet-process kilns. Raw materials consumed in making portland cement were 1.7 million tons of limestone, 0.7 million ton of cement rock, 0.3 million ton of clay, and smaller amounts of bauxite, iron ore, sand, shale, and various chemicals. Fuels used were natural gas and bituminous coal.

Cement produced was gray finished portland cement, classified as "general use, moderate heat type," "early strength," and "very high sulfur resistance." The price of oil well cement, whose output was related to drilling activities, fell from $43.94 per ton in 1986 to $39.37, reflected the ongoing sluggishness in the oil industry.

In decreasing order of quantity, finished portland cement was sold to ready-mixed concrete companies (66% of shipments), highway contractors, other contractors, miscellaneous customers, concrete product manufacturers, building material dealers, and government agencies. Bulk shipments of portland cement from plant to terminals were transported by rail (99.7% of shipments) and by truck.

Iodine.—On October 1, Iochem Corp., a Japanese company, opened a new iodine plant east of Vici, Dewey County. The firm produced about 20 tons of iodine per month at yearend 1987 from brines extracted from 10,000-foot-deep wells. The new plant employed 25 people and was the third iodine-producing plant in the United States, all in northwestern Oklahoma.

Sand and Gravel.—(Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Cement-Roadstone Holdings (CRH), Ireland's largest industrial company, acquired 50% of Boorham-Fields Inc. Boorham operated limestone quarries in Oklahoma, including a new 1-million-ton-per-year facility in southern Oklahoma that would serve the north Dallas, TX, market.[5]

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the five Oklahoma districts depicted in figure 1.

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Table 3.—Oklahoma: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	95	468
Riprap and jetty stone	148	543
Filter stone	69	345
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,895	6,890
Bituminous aggregate, coarse	154	702
Bituminous surface-treatment aggregate	692	2,811
Railroad ballast	650	2,991
Fine aggregate (-3/8 inch): Screening, undesignated	1,028	1,716
Coarse and fine aggregates:		
Graded road base or subbase	905	2,035
Unpaved road surfacing	165	777
Crusher run or fill or waste	527	1,459
Other coarse and fine aggregate	376	712
Other construction[2]	189	224
Agricultural: Agricultural limestone	79	224
Chemical and metallurgical: Cement manufacture	2,525	4,696
Special: Asphalt fillers and extenders	13	26
Other unspecified[3]	15,645	57,112
Total	25,155	[4]83,732

[1]Includes limestone, granite, and sandstone; dolomite withheld to avoid disclosing company proprietary data.
[2]Includes stone sand (concrete and bituminous mix or seal).
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Table 4.—Oklahoma: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4		District 5	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	--	--	108	453	73	250	132	653	--	--
Coarse aggregate, graded[2]	--	--	1,803	6,777	560	2,221	1,028	4,397	--	--
Fine aggregate (-3/8 inch)[3]	--	--	804	1,091	301	727	26	35	--	--
Coarse and fine aggregates[4]	--	--	1,125	2,980	320	839	528	1,165	--	--
Other construction	--	--	(5)	1	--	--	86	86	--	--
Agricultural[6]	--	--	11	46	W	W	--	--	W	W
Chemical and metallurgical[7]	--	--	W	W	W	W	W	W	W	W
Special[8]	--	--	--	--	--	--	13	26	--	--
Other miscellaneous	--	--	784	1,541	988	1,453	623	1,360	197	521
Other unspecified[9]	--	--	2,654	8,114	524	3,434	8,683	31,445	3,783	14,120
Total[10]	--	--	7,289	21,002	2,766	8,924	11,119	39,166	3,980	14,641

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Less than 1/2 unit.
[6]Includes agricultural limestone.
[7]Includes cement manufacture.
[8]Includes asphalt filler.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

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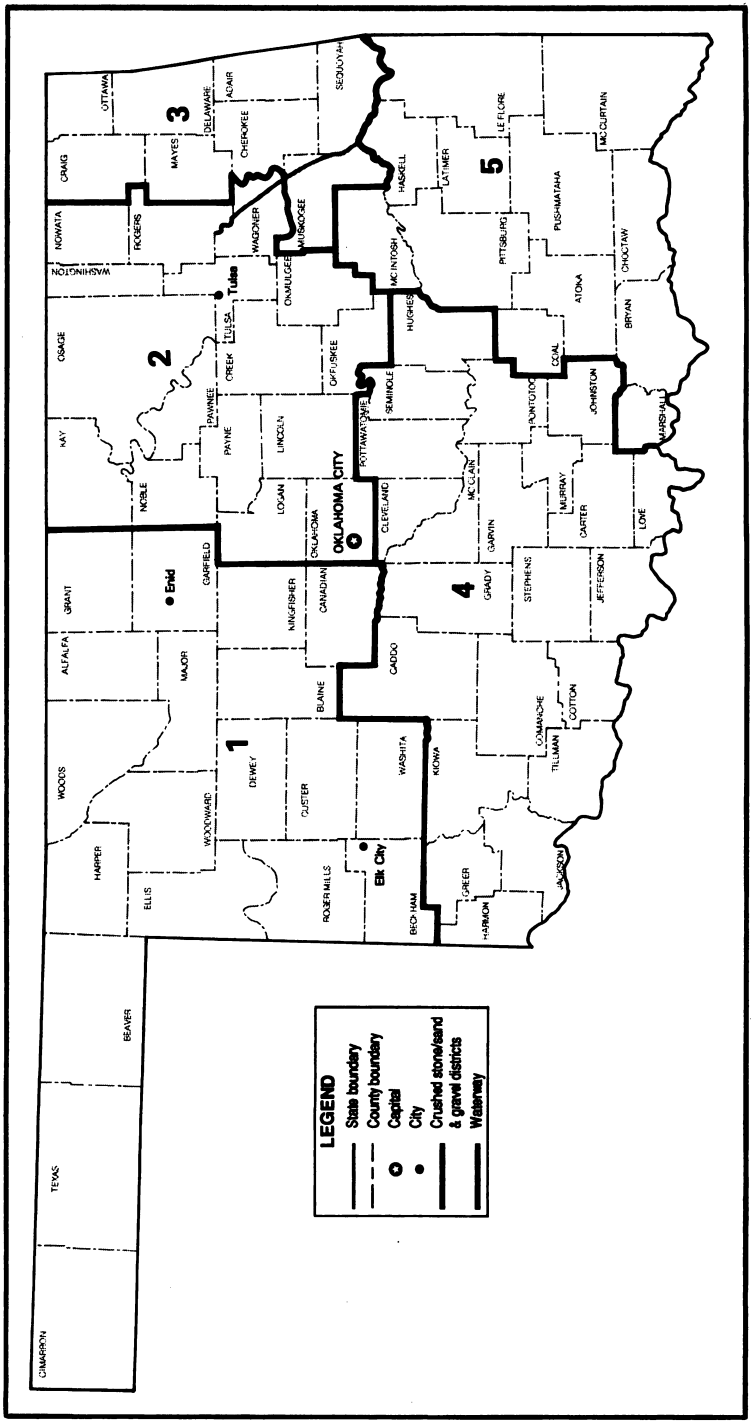

Figure 1.—Aggregate-producing districts in Oklahoma.

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Other Industrial Minerals.—Agrico Chemical Co., purchased by Freeport McMoRan Resource Partners in January 1987, produced about 2,700 tons per day of ammonia, used principally in the production of liquid urea ammonium nitrate, at its Verdigris plant. Nearby natural gas sources supplied raw material to the plant, which is in Rogers County.

Oklahoma was one of six States reporting feldspar production. Arkhola Sand and Gravel Co., a subsidiary of APAC Arkansas Inc., worked its pit in Muskogee County. Feldspars were used in electrical insulators, enamels, glassmaking, pottery, and soaps.

Cargill Inc., Salt Div., at Freedom, Woods County, halted salt output from its solar ponds in October because of excessive rains. Cargill hoped to resume production in late 1988.

W. R. Grace & Co. exfoliated vermiculite at its Oklahoma City plant from raw material shipped in from out-of-State. Sales and total value declined moderately but unit price rose 3.7%.

METALS

Cadmium.—Cadmium metal was produced by Zinc Corp. of America (ZINCOA), at its Bartlesville plant. Zinc Corp. was formed in 1987 by combining the operations of St. Joe Resources Co. (a of subsidiary Fluor Corp.) and those of New Jersey Zinc Co. Inc. (a division of Horsehead Industries Inc.) Recovered as a byproduct of the smelting of domestic and imported zinc concentrates, cadmium was used mainly in batteries, coating, and plating.

Germanium.—Eagle-Picher Industries Inc. was awarded a General Services Administration contract to supply the first 2,000 kilograms of germanium metal from its plant at Quapaw to the National Defense Stockpile. By early August, 5,000 kilograms more were purchased from Eagle-Picher for the stockpile at $731 per kilogram. The germanium is a byproduct of zinc production.

Uranium.—Sequoyah Fuels Corp.'s plant at Gore was expanded to manufacture uranium tetrafluoride. In November, Kerr-McGee Corp., Sequoyah Fuels' parent, agreed in principle to sell the subsidiary to GA Technologies Inc. (formerly called General Atomics), of San Diego, CA. GA Technologies would continue operations at Gore.

Zinc.—St. Joe Resources sold its zinc refinery at Bartlesville to Horsehead Industries, a New York-based manufacturing firm.

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[1]State Mineral Officer, Bureau of Mines, Denver, CO.
[2]Director, Oklahoma Mining & Mineral Resources Research Institute, Oklahoma Geological Survey, Norman, OK.
[3]Construction Activity. Oklahoma Business Bull., v. 56, issue 3, Mar. 1988, p. 11.
[4]Tri-State Cleanup Done. Water Quality, U.S. Water News, Apr. 1987, p. 9.
[5]Boorham-Fields Acquired by Irish Holding Firm. Pit & Quarry, Mar. 1987, p. 14.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Blue Circle Inc., a subsidiary of Blue Circle Industries Ltd.[1 2]	One Parkway Center 1850 Parkway Place Suite 1000 Marietta, GA 30067	Quarry and plant	Rogers.
Ideal Basic Industries Inc., Ideal Cement Co.[1 2]	Box 8789 Denver, CO 80201	do	Pontotoc.
Lone Star Industries Inc.[1 2]	5110 Maryland Way Suite 222 Brentwood, TN 37027	do	Mayes.
Clays:			
Acme Brick Co., a subsidiary of Justin Industries Inc.	Box 24012 Oklahoma City, OK 73124	Pit and plants	Oklahoma.
Chandler Materials Co	5805 East 15th St. Tulsa, OK 74102	Pit and plant	Do.
Commercial Brick Corp	Box 1382 Wewoka, OK 74884	do	Seminole.
Oklahoma Brick Corp., a subsidiary of Merry Co.	Box 75368 4300 NW. 10th St. Oklahoma City, OK 73127	do	Canadian and Muskogee.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Feldspar:			
Arkhola Sand and Gravel Co., a division of APAC-Arkansas Inc., a subsidiary of Ashland Oil Co.[2 3]	Box 1401 Muskogee, OK 74401	Dredge and plant	Muskogee.
Gallium and germanium:			
Eagle-Picher Industries Inc	Box 737 Quapaw, OK 74363	Refinery	Ottawa.
Gypsum:			
Harrison Gypsum Co. Inc	Box 336 Lindsay, OK 73052	Quarry	Caddo.
Heartland Cement Co	Box 428 Independence, KS 67301	do	Blaine.
Republic Gypsum Co	Drawer C Duke, OK 73532	Quarry and plant	Jackson.
Temple-Eastex Inc	Box 101 Fletcher, OK 73541	do	Comanche.
United States Gypsum Co., a subsidiary of USG Corp.	Box 187 Southard, OK 73770	do	Blaine.
Iodine:			
North American Brine Resources	c/o Beard Oil Co. 2000 Classen Center Bldg. Oklahoma City, OK 73106	Oilfield brines and plant.	Kingfisher.
Woodward Iodine Corp., a subsidiary of Asahi Glass Co. Ltd. and Ise Chemical Co.	Box 1245 Woodward, OK 73801	Brine field and plant.	Woodward.
Lime:			
St. Clair Lime Co	Box 894 Oklahoma City, OK 73101	Mine and plant	Sequoyah.
Pumice (volcanic ash):			
Axtell Mining Corp	Box 92 Gate, OK 73844	Open pit	Beaver.
Salt:			
Cargill Inc	Box 167 Freedom, OK 73842	Solar evaporation	Woods.
Sand and gravel:			
Construction:			
Boorhem-Fields Inc.[2]	Star Route B Box 284A Kingston, OK 73439	Quarries	Bryan.
The Dolese Co.[2]	Box 677 Oklahoma City, OK 73101	Pits and plants	Canadian, Kingfisher, Logan, Oklahoma.
Gainesville Sand & Gravel Co	Thackerville, TX 73459	Pit and plant	Love.
Lemon Haskell Construction Co. of General Materials Co. Inc.	Box 75608 Oklahoma City, OK 73147	Pits and plant	Cleveland.
Industrial:			
UNIMIN Corp	258 Elm St. New Canaan, CT 06840	Pit and plant	Pontotoc.
U.S. Silica Co	Box 187 Berkeley Spring, WV 25411	Pits and plant	Johnston.
Stone:			
Crushed:			
Amis Materials Co	Box 168 Stringtown, OK 74569	Quarry	Atoka.
Anchor Stone Co. and Tulsa Rock Co., subsidiaries of Anchor Industries.	3300 North Mingo Valley Expressway Tulsa, OK 74116	do	Rogers and Tulsa.
Bellco Materials Inc.[3]	Box 466 Nowata, OK 74048	Quarries	Nowata, Rogers, Washington.
Material Producers Inc	Box 577 Norman, OK 73070	Quarry	Murray.
McNabb Stone Co., a division of McNabb Coal Co. Inc.	Drawer C Catoosa, OK 74015	Quarries	Rogers and Wagoner.
Meridian Aggregates Co., a subsidiary of Burlington Northern Railroad.	Box 86 Mill Creek, OK 74856	Quarry	Johnston.
The Quapaw Co	Box 72 Drumright, OK 74030	Quarries	Creek and Pawnee.
Sooner Rock & Sand Co., a subsidiary of Hallet Construction Co.	Box 1549 Norman, OK 73070	Quarry	Murray.
Standard Industries, a division of APAC-Oklahoma Inc.	Box 580670 Tulsa, OK 74158	Quarries	Cherokee, Kay, Mayes, Tulsa.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Dimension:			
Bodie L. Anderson Quarries Inc	Box 106 Mill Creek, OK 74856	Quarry	Johnston.
Miller Stone Co	Route 1 Hackett, AR 72937	____do_____	Le Flore.
Pontotoc Stone Co	1434 NW. 30th St. Oklahoma City, OK 73118	____do_____	Johnston.
J. R. Willis Granite Co. Inc	Box 188 Granite, OK 73547	____do_____	Greer.
Tripoli:			
American Tripoli Co	Box 489 Seneca, MO 64865	Mines	Ottawa.
Zinc:			
Zinc Corp. of America, a division of Horsehead Industries Inc.[4]	Box 579 Bartlesville, OK 74005	Electrolytic refinery.	Washington.

[1]Also clays.
[2]Also stone.
[3]Also sand and gravel.
[4]Also sulfuric acid; copper, lead, and silver residues; and cadium balls.

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The Mineral Industry of Oregon

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Oregon Department of Geology and Mineral Industries for collecting information on all nonfuel minerals.

By W. L. Rice[1]

Oregon's nonfuel mineral production value rose to $161 million in 1987, an increase of about 27% from 1986. Gains in the value of cement, diatomite, sand and gravel, and stone production were largely responsible for the increase. Industrial minerals accounted for 97% of the nonfuel mineral production value reported for 1987. Crushed stone was the leading commodity in terms of value, followed by construction sand and gravel, cement, lime, and diatomite. Oregon ranked 38th in the Nation in value of nonfuel minerals produced in 1987, up from the 39th ranking achieved in 1986.

Trends and Developments.—Oregon's aluminum industry achieved a nearly total recovery from the severe industrywide downturn experienced in both 1985 and 1986. Improved international market conditions and consequent increased aluminum prices led to the resumption of full-scale production at one smelter and an increase to 80% of capacity at the State's other reduction plant.

Although gold production from the State remained at a relatively low level in 1987, exploration and development of epithermal gold discoveries in eastern Oregon were expected to lead to a 1988 production decision at one significant deposit.

Table 1.—Nonfuel mineral production in Oregon[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	188	$285	204	$289	268	$986
Gem stones	NA	e$350	NA	350	NA	350
Nickel (content of ore and concentrate) short tons	6,127	W	1,175	W	--	--
Sand and gravel (construction) thousand short tons	e12,500	e36,800	13,441	42,597	e13,000	e42,200
Stone (crushed) ---------- do	15,336	54,244	e15,100	e53,400	20,663	73,902
Talc (soapstone) ---------- do	(2)	30	(2)	41	(2)	14
Combined value of cement, diatomite, gold, lime, pumice, silver (1987), stone (dimension, 1985-86), and values indicated by symbol W ----------	XX	38,587	XX	29,755	XX	43,544
Total ----------	XX	130,296	XX	126,432	XX	160,996

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Less than 1/2 unit.

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Table 2.—Nonfuel minerals produced in Oregon in 1986, by county[1]

County	Minerals produced in order of value
Baker	Cement, clays, gold.
Benton	Sand and gravel.
Clackamas	Do.
Clatsop	Do.
Columbia	Do.
Crook	Do.
Curry	Do.
Deschutes	Pumice.
Douglas	Sand and gravel.
Grant	Do.
Harney	Do.
Jackson	Sand and gravel, talc.
Jefferson	Sand and gravel.
Josephine	Sand and gravel, gold.
Klamath	Clays.
Lake	Diatomite.
Lane	Sand and gravel.
Lincoln	Do.
Linn	Do.
Malheur	Diatomite, sand and gravel.
Marion	Sand and gravel.
Morrow	Do.
Multnomah	Sand and gravel, lime, clays.
Polk	Sand and gravel.
Tillamook	Do.
Umatilla	De.
Wasco	Do.
Washington	Do.
Yamhill	Do.
Undistributed[2]	Stone (crushed), sand and gravel, nickel, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

More than three decades of nickel production in Oregon came to an end in 1987. Persistently depressed nickel prices and technical problems led to the permanent closure of the Nation's only integrated nickel mine and smelter. Adverse economics rendered it very unlikely that the State's other nickel laterite deposits would be developed in the foreseeable future.

Employment.—According to the Oregon Employment Division, Department of Human Resources, the State's 1987 mining and quarrying employment remained at 1,400 workers, identical to the figure recorded for 1986. Reflecting the midyear revival in the domestic aluminum reduction industry, employment in the nonferrous metals segment of Oregon's primary metals industry increased to 3,700 from the 3,300 workers employed in 1986. In 1987, blast furnace and iron and steel foundry sector employment rose to 5,600 from the 5,300 worker total recorded for 1986. Weekly wages for primary metals industry workers averaged $506.82 for a work week of 41.7 hours.

Environmental Issues.—More than 40 suppliers of scrap lead storage batteries to Bergsoe Metal Corp.'s secondary lead smelter at St. Helens, Columbia County, were notified of possible liability for hazardous waste found at the site. The operation was shut down in mid-1986, and Bergsoe was given chapter 11 protection under provisions of the Federal Bankruptcy Code. Both the Federal Environmental Protection Agency (EPA) and the Oregon Department of Environmental Quality (DEQ) asserted that there had been a release of hazardous waste from spent lead batteries. Cost of the cleanup was estimated to be between $5 million and $20 million, depending on whether the work was performed through a private party or done by a government agency.

In May, Teledyne Wah Chang Albany (TWCA) announced a plan to move 100,000 cubic yards of slightly radioactive waste sludge out of the Willamette River flood plain at its zirconium plant near Albany, Linn County. If the plan is approved by the EPA and DEQ, zirconium refinery waste would be pumped to a permanent earthquake-resistant, lined and capped containment structure about 1 mile from the river. Cost for removal of the sludge could run as high as $10 million.

Exploration Activities.—Metallic mineral exploration activity in Oregon was primarily for precious metals deposits in the southwestern, southeastern, and northeastern parts of the State. In 1987, 4,486 new mining claims were filed, for a total of 44,429 active unpatented mining claims in the State; a total of 28,741 claims had been filed since January 1, 1976. Nearly 72% of the new claims filed in 1987 were in Baker, Grant, Harney, Jefferson, and Malheur Counties.

Legislation and Government Programs.—The Oregon Legislative Assembly enacted a law requiring a mine operator using a cyanidation process to extract precious metals to file a surety bond with the DEQ. The new law directed that agency to draft regulations determining the amount of bonding required, and to set standards for reclamation of a cyanidation processing site.

The Oregon sunstone, a gem variety of the feldspar mineral group, was made the official State gem stone by proclamation of the Governor and by a joint resolution of the Oregon Legislative Assembly.

In March, the Bonneville Power Administration (BPA) inaugurated a $76 million, 10-year conservation and modernization program to aid the troubled northwest aluminum industry. Under terms of the program,

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companies owning smelters will receive 0.5 cent for every kilowatt hour of electricity saved from the amount needed to produce a pound of aluminum. By yearend, the two companies operating smelters in Oregon had applied to modernize their operations.

The Oregon Department of Geology and Mineral Industries (DOGAMI) celebrated its 50th anniversary in 1987, having been created by legislation passed on March 1, 1937.

Mineral leasing payments to Oregon by the U.S. Bureau of Land Management totaled $618,000 in 1987.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Portland cement production increased nearly 6% in volume and was up 20% in value from 1986. The State's only cement producer, Ash Grove Cement West Inc., operated a limestone quarry and cement plant near Durkee, Baker County, throughout the year.

Most of the cement produced was general use and moderate heat Types I and II gray portland cement; a small quantity of masonry cement also was produced. Portland cement produced in the State was used by ready-mix concrete companies (77%), highway contractors (10%), concrete product manufacturers (10%), building material dealers (2%), and other contractors, government agencies, and miscellaneous customers (1%). Raw materials consumed in the manufacture of cement were locally mined calcarous cement rock, clay, shale, and imported iron ore and gypsum. The one-kiln, dry-process cement plant used fuel oil and bituminous coal for fuel, and electricity was purchased for energy.

Clays and Zeolite.—Oregon's 1987 clay production increased by about 31% in quantity and more than tripled in value. Common clay, used chiefly in bricks, ceramic tile, and cement, was mined by four companies from five deposits in Baker, Jackson, Klamath, Lane, and Multnomah Counties.

Teague Mineral Products Co. produced bentonite clay near Adrian, Malheur County; the material was sold for drilling mud, as a binder for cattle feed pelletizing, and as a sealant for ponds, ditches, and waste-disposal sites. Bentonite also was mined by Central Oregon Bentonite Co. and Oregon Sun Ranch Inc. from pits on Camp Creek, Crook County. Central Oregon Bentonite's production was used in drilling mud and pond sealant; the Oregon Sun Ranch bentonite was sold for pet waste absorbent.

Teague also produced the zeolite mineral clinoptilolite from the Succor Creek open pit, Malheur County. The processed zeolite product was sold for pet waste absorbent, odor control products, fungicide carriers, and ammonia absorbent in aquarium systems. During the year, Teague did research on the potential of potassic clinoptilolite for improving chicken feed efficiency, and on ways to increase brightness of the mineral for paper manufacture. The company also worked with an environmental contractor in the use of clinoptilolite for the solidification of liquid wastes contaminated by pentachlorophenol and by other hazardous substances. This was believed to be the first use of natural zeolite in hazardous-waste solidification.

Diatomite.—Oregon's diatomite production more than doubled in quantity and tripled in value from that reported in 1986; the State again ranked fourth in the Nation for diatomite production.

The significant increase in both quantity and value was attributed to the first full year of production by Eagle-Picher Industries Inc. at the Celatom diatomite processing plant near Vale, Malheur County. Diatomite was processed by crushing, grinding, air classification, and flux calcining (partial fusion and agglomeration) into filter aids for water and food processing, and for pharmaceuticals. The diatomite was pit mined from sites in the Juntura Basin near Drewsey, Harney, and Malheur Counties. Mining and stockpiling were done in the summer months; the ore was trucked 70 miles to the Vale plant.

Oil-Dri Production Co. continued diatomite production from an open pit and processing plant in Christmas Valley, Lake County. The diatomite was packaged as pet litter for several companies and sold under various brand names.

Graphite.—Toyo Tanso Ltd., Osaka, Japan, constructed a $3 million to $4 million graphite plant in Portland. The plant will manufacture synthetic graphite that is consumed by the silicon wafer, aluminum, and aircraft industries.

Lime.—Lime production increased nearly 17% in quantity and almost 14% in value from 1986. Ash Grove Cement, Multnomah

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County, and Amalgamated Sugar Co. at Nyssa, Malheur County, produced throughout the year. About 87% of the reported production was quicklime; Ash Grove was responsible for all of the State's hydrated lime production. All of Amalgamated Sugar's output was used in-house for sugar refining; Ash Grove's lime was used for industrial applications and in sugar processing.

Perlite.—Supreme Perlite Co. manufactured expanded perlite at Portland, Multnomah County. Quantity of the product remained the same as in 1986, but a slight increase was noted in value.

Pumice.—Oregon ranked first in the Nation for pumice production in 1987. Quantity and value of production increased only slightly from 1986 levels.. Cascade Pumice Co. and Central Oregon Pumice Co. extracted pumice from two open pits in the Bend area, Deschutes County. Processed pumice from the two operations was used for lightweight concrete aggregate (48%), building and decorative block (36%), landscaping (8%), road construction and maintenance (5%), and roofing (3%).

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

The 1987 output of construction sand and gravel in the State was estimated to be down slightly from that reported in 1986.

Industrial.—CooSand Corp. produced silica sand from sand dunes at Coos Bay, Coos County. The sand was rail-shipped to Portland and sold for sandblasting sand, railroad traction sand, and for the production of colored glass containers.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Reflecting the predominantly volcanic nature of the State's geology, Oregon was the leading domestic producer of crushed traprock and of volcanic cinder and scoria in 1987.

The 1987 output and value of crushed stone were up more than 35% from 1985 levels. Crushed stone production was well distributed among the State's 36 counties, although 5—Baker, Douglas, Lane, Washington, and Yamhill—accounted for 30% of the total; Lane and Yamhill Counties were the leading producers.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the four Oregon districts depicted in figure 1.

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Table 3.—Oregon: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	43	97
Riprap and jetty stone	549	1,225
Filter stone	74	295
Coarse aggregate, graded:		
Concrete aggregate, coarse	114	438
Bituminous aggregate, coarse	432	1,401
Bituminous surface-treatment aggregate	935	4,238
Railroad ballast	417	1,597
Fine aggregate (-3/8 inch): Stone sand, bituminous mix or seal	71	306
Coarse and fine aggregates:		
Graded road base or subbase	6,349	25,501
Unpaved road surfacing	959	3,502
Crusher run or fill or waste	718	3,229
Other coarse and fine aggregates	113	318
Other construction[2]	166	408
Special: Other miscellaneous[3]	594	1,713
Other unspecified[4]	9,129	29,635
Total	20,663	[5]73,902

[1]Includes limestone, volcanic cinder and scoria, granite, quartzite, and miscellaneous stone.
[2]Includes stone sand (concrete), fine aggregate (screening, terrazzo and exposed aggregate, and coarse aggregate (graded).
[3]Includes cement manufacture and asphalt fillers and extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.

Table 4.—Oregon:[1] Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (including concrete sand)[2]	463	893	94	265	36	94	--	--
Coarse aggregate, graded[3]	1,214	5,035	30	127	145	554	314	1,111
Fine aggregate (-3/8 inch)[4]	W	317	--	--	W	W	--	--
Coarse and fine aggregates[5]	2,943	9,632	1,193	3,959	W	W	W	W
Other construction	213	170	3	9	258	845	722	2,978
Chemical and metallurgical[6]	--	--	--	--	--	--	(7)	(7)
Special[8]	(7)	(7)	--	--	--	--	--	--
Other miscellaneous	12	259	--	--	--	--	581	1,454
Other unspecified[9]	2,875	9,506	457	1,285	214	634	--	--
Total[10]	7,721	25,812	1,776	5,643	653	2,127	1,617	5,543

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Excludes 8,895,832 short tons valued at $34,776,460 not reported by counties.
[2]Includes macadam, riprap and jetty stone, and filter stone.
[3]Includes concrete aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[4]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screen).
[5]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[6]Includes cement manufacture.
[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[8]Includes asphalt filler.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

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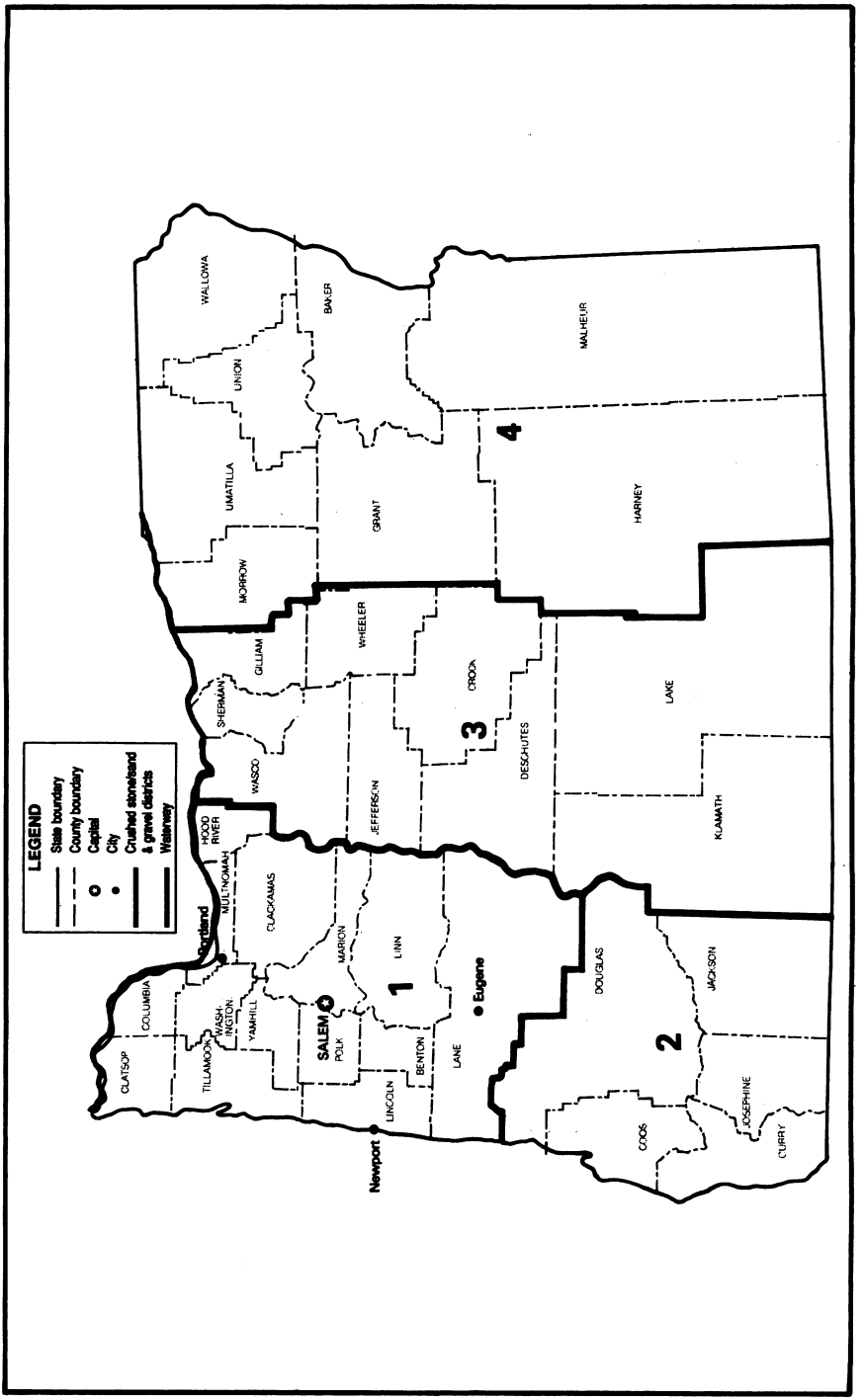

Figure 1.—Aggregate-producing districts in Oregon.

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Bristol Silica and Limestone Co. produced silica from a quarry in Jackson County; the rock was sold for poultry grit, decorative granules, sandblasting, and as a filtration medium.

PyroPacific Inc., a Klamath Falls fire-resistant products company, secured the patent rights for a process to make a high-strength mineral fiber from basalt. The inert fiber could replace asbestos in many applications; the long basalt fibers do not present the health hazard attributed to short fiber asbestos. The company planned on a first-year output of 14 million pounds of basalt fiber, with production projected for middle to late 1988. Because fiber production requires basalt of a certain chemical composition, the company was examining several sites in Idaho, Oregon, and Washington. The production plant would be built near the basalt source, with a projected initial employment of 16 to 18 people.

Talc (Soapstone).—Steatite of Southern Oregon Inc. produced high-grade variegated-color soapstone from a southern Jackson County property. The product was marketed worldwide for art carving and other specialty uses. Production for 1987 was nearly three times that of 1986, although value decreased substantially.

METALS

Aluminum.—Primary aluminum production in the State nearly tripled in quantity and value in 1987.

Oregon's depressed aluminum industry responded to a marked easing of the worldwide aluminum oversupply, and it was well into a revival by midyear. The State's two aluminum smelters, which operated at about 45% of total rated ingot capacity in January, finished the year operating at nearly 92% of the rated annual capacity of 220,000 short tons of aluminum ingot. Prices for the metal, which started the year at about $0.53 per pound, advanced to approximately $0.74 per pound in early June, and rose to nearly $0.88 per pound by yearend.

Reynolds Metals Co. progressively restarted idled potlines at the Troutdale smelter during 1987. Reynolds started the year at an operating rate of 55,000 tons of ingot; potline restarts in February, May, and September brought the plant up to its rated annual capacity of 130,000 tons of aluminum ingot. The work force rose from about 300 in January to more than 700 at yearend.

Northwest Aluminum Co. partially restarted a potline in mid-May at its smelter in The Dalles. A restart of 90 cells in the smelter's second potline brought the plant up to 80% of capacity; annual production increased from 45,000 tons of ingot to 72,000 tons. The restart added 95 jobs to the 188-person work force. Northwest Aluminum operated as a tolling smelter, processing alumina for Clarendon Ltd.

Columbium, Hafnium, Tantalum, and Zirconium.—TWCA was listed among seven major producers of columbium in 1987. The company produced high-quality superalloys for jet engines, special alloys for aerospace application, chemical processing equipment, and superconductor components; it also produced columbium pentoxide and high-purity ferrocolumbium for use in superalloys.

Tantalum products by TWCA were used for chemical processing equipment and aerospace engine components. TWCA was the leading domestic producer of zirconium and hafnium; the zirconium was used in nuclear reactors, photographic flash cubes, and for corrosion-resistant chemical industry applications. Hafnium, a byproduct of zirconium processing, was used for control rods in nuclear reactors.

Copper, Gold, and Silver.—Gold and silver production increased substantially from that recorded in 1986. Lode gold and silver production was reported from one mine in Baker County, and gold production was reported from one mine in Josephine County.

According to a company report to the State of Oregon, Silver King Mines Inc. produced 15,000 tons of gold-copper ore from the underground Iron Dyke Mine at Homestead, Baker County. The ore, averaging 3.5% copper, 0.35 troy ounce of gold, and 0.5 troy ounce of silver per ton, was trucked to Silver King's mill at the Copper Cliff Mine near Cuprum, ID. The Iron Dyke operation was reactivated in 1986, after being closed in the fall of 1984 owing to low metal prices. A drilling program to increase reserves was started in December 1987.

ORECO Enterprises conducted a heap-leach operation at the Oregon King Mine in the Ashland District, Jefferson County. The seasonal operation shut down with the onset of winter, and was scheduled to reopen in the spring of 1988.

Geo Gold and Silver-Josephine County Partners optioned the Greenback Mine, Josephine County. In 1987, the company rebuilt the mill, opened up the lower workings, and produced some gold. The com-

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pany reportedly milled dump ore from the Hammersly Mine.

Other lode gold properties showing some activity during the year were the Golden Eagle, Lower Grandview, Virtue, and Gold Ridge Mines, all in Baker County; Maid of the Mist in Jackson County; the Gold Blanket, Josephine County; and the Pyx Mine in the Greenhorn District, Grant County.

Exploration activity was accelerated in 1987 at the Quartz Mountain gold property in Lake County, a joint venture of Quartz Mountain Gold Corp. and Galactic Resources Ltd. During the year, 460 holes were drilled, increasing the total number of drill holes to 623 on the 10,000-acre property. Reserves calculated in May at the Quartz Butte and Crone Hill deposits totaled 47.5 million tons, grading 0.03 ounce of gold per ton. Subsequent drilling increased the estimates of reserves significantly and revealed high-grade zones at Angels Camp and beneath known ore at Crone Hill. Gold occurrences at Angels Peak, Drews Creek, and three additional prospects to the east remained to be explored. Galactic Resources announced that a final feasibility study and a production decision were scheduled for the first quarter, 1988. Initial open pit, heap-leach production was projected from near-surface, oxidized ore at the Crone Hill deposit.

Thomas Bonn's Bonanza Placer, on Pine Creek in the Cornucopia District of Baker County, was the State's largest placer operation in 1987. The company acquired two major tracts of placer ground during the year, and announced plans for a 10-year period of operation. Other Baker County placer operations were active on Pine Creek near Hereford, and on Clarks Creek in the Burnt River drainage.

Several small-scale, seasonal placer mines were operated in Josephine County on Josephine Creek and tributaries, on Sucker Creek, lower Grave Creek, Coyote Creek, in the Galice area, and on Coffee Creek in Douglas County.

Iron and Steel.—The iron and steel foundry industry in Oregon which, since 1984, had decreased by about 50%, with a concomitant production employment decline from 4,154 to 3,500, had a marginally better year in 1987. The six surviving companies specialized in product lines unaffected by cheaper imported castings. At least one company diversified from basic iron castings into ductile iron and cast steel products.

A midyear proposal was made by Hyundai Corp., Republic of Korea, to build a steel mill in Oregon to process scrap steel into bars, tubes, and other products. Later in the year, the National Steel Producers Association urged Federal lawmakers to discourage the proposed mill, which it claimed would have a deleterious effect on an already saturated domestic market. Hyundai's proposed mill could employ up to 400 people, according to company estimates.

Oregon Steel Mills Inc. (formerly Gilmore Steel Corp.) reported that 1987 was its most productive year, with shipments exceeding 300,000 tons of steel plate and profits registered in all four quarters. Technological improvements in the plant, substantial savings in energy consumption, diversification of product lines, and an aggressive marketing program combined to register more than $127 million in sales, compared with $60 million in 1982.

Nickel.—In early January, the M. A. Hanna Co. announced permanent closure of its wholly owned ferronickel mine and smelter at Riddle, Douglas County, ending 30 years of operation. The sole domestic nickel producer was shut down in August 1986, owing to low nickel prices and problems with a newly installed wet-screening, slurry-transport system. About 270 remaining employees, from a peak work force of 650, lost their jobs. In November, Hanna sold the smelter facility—including mineral rights, real estate, and power contracts it held with the BPA—to Universal Consolidated Cos. of Fremont, OH. Universal Consolidated formed a subsidiary company, Nickel Mountain Resources, to operate the smelter as a ferrosilicon producing facility. Nickel Mountain planned to be in operation by mid-1988, employing 50 to 70. The ferrosilicon product would be sold to domestic steel mills, with a possible expansion to markets in Japan and the Republic of Korea.

Silicon.—A scheduled March 31 shutdown of Dow Corning Corp.'s silicon metal plant in Springfield, Lane County, was averted when the company secured a rate reduction from the BPA and ratified a 3-year labor contract involving temporary wage reductions. The Springfield plant was Dow Corning's only silicon metal producer; plant output was used by the parent organization in the production of silicones and silanes.

In midyear, Nippon Kokan K.K. of Tokyo, Japan, started construction of a $60 million polycrystalline silicon plant at Millerburg, Linn County. The subsidiary, Great West-

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ern Silicon (Oregon) Corp., was expected to produce 1,000 metric tons of polycrystalline silica per year with a work force of 100 people in the first production phase. Start-up was projected for mid-1988. Relatively low energy costs, a steady supply of raw material, and proximity to markets in the United States and Japan, were deciding factors in siting the operation.

Titanium.—Oregon Metallurgical Corp. (OREMET) produced high-purity titanium sponge, titanium metal, titanium mill products, and titanium and zirconium castings at the Albany plant. Owens-Corning Fiberglas Corp. sold its 80% interest in OREMET through an employee stock ownership plan; the sale was concluded in December. A marked improvement in the titanium market and a broadened product line enabled OREMET to post a profit for 1987; the company had declared a loss in 1986.

[1]State Mineral Officer, Bureau of Mines, Spokane, WA.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Northwest Aluminum Co	3313 West 2d St. The Dalles, OR 97058	Smelter	Wasco.
Reynolds Metals Co	5100 NE. Sundial Rd. Troutdale, OR 97060	do	Multnomah.
Cement:			
Ash Grove Cement West Inc.[1]	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Plants and quarries.	Baker.
Diatomite:			
Eagle-Picher Industries Inc	Graham Blvd. Vale, OR 97918	Surface mine and plant.	Harney and Malheur.
Oil-Dri Production Co	Box 191 Christmas Valley, OR 97638	do	Lake.
Gold:			
Silver King Mines Inc.[2]	Box 149 Oxbow, OR 97840	Underground mine.	Baker.
Lime:			
Amalgamated Sugar Co	Box 1766 Nyssa, OR 97913	Plant	Malheur.
Ash Grove Cement West Inc	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	do	Multnomah.
Perlite (expanded):			
Supreme Perlite Co	4600 North Suttle Rd. Portland, OR 97217	do	Do.
Pumice:			
Cascade Pumice Co	Box 1087 Bend, OR 97701	Pit	Deschutes.
Central Oregon Pumice Co	5 NW. Greenwood Ave. Bend, OR 97701	Pit	Do.
Stone (Crushed):			
Ash Grove Cement West Inc.	5550 SW. Macadam Suite 300 Portland, OR 97201	Quarry	Baker.
Karbon Rock Inc	3707 24th Beaverton, OR 97005	do	Washington.
Lone Star Industries Inc.	Box 1730 Seattle, WA 98111	do	Do.
Rogers Construction Co	Box 730 Umatilla, OR 97882	do	Umatilla.
U.S. Forest Service, Region 6	319 SW. Pine St. Portland, OR 97208	Quarries	Various.
Talc (soapstone):			
Steatite of Southern Oregon Inc	2891 Elk Lane Grants Pass, OR 97526	Surface mine and mill.	Josephine.
Titanium:			
Oregon Metallurgical Corp	Box 580 Albany, OR 97321	Smelter	Linn.
Zeolite:			
Teague Mineral Products Co.[3]	Box 35-C, Route 2 Adrian, OR 97901	Surface mine and plant.	Malheur.
Zirconium:			
Teledyne Wah Chang Albany[4]	1600 NE. Old Salem Rd. Albany, OR 97321	do	Do.

[1]Also clays, pumicite, and crushed stone.
[2]Also silver.
[3]Also bentonite.
[4]Also columbium, hafnium, tantalum, and vanadium.

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The Mineral Industry of Pennsylvania

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1] and Robert C. Smith[2]

In 1987, the value of nonfuel mineral production in Pennsylvania surpassed $1 billion for the first time in history. The State became one of nine that reported nonfuel mineral production valued at more than $1 billion, and it accounted for nearly 4% of the U.S. total.

Pennsylvania's 21% increase in value of nonfuel mineral output over 1986 resulted primarily from unprecedented production of 97 million short tons of crushed stone. That total was the highest ever reported in the United States and ranked Pennsylvania first in output of crushed stone. The other mineral commodities produced in Pennsylvania showed little change in production levels over 1986.

Table 1.—Nonfuel mineral production in Pennsylvania[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	303	$20,970	391	$26,683	397	$30,484
Portland do	5,535	288,036	6,290	324,187	6,325	334,709
Clays[2] do	1,142	5,293	1,284	5,061	1,206	4,751
Gem stones	NA	e5	NA	5	NA	5
Lime thousand short tons	1,492	85,269	1,417	81,234	1,574	93,420
Peat do	21	602	19	532	18	513
Sand and gravel:						
Construction do	e17,000	e74,000	15,373	68,880	e14,800	e72,900
Industrial do	693	9,846	688	10,091	W	W
Stone:						
Crushed do	64,765	310,859	e63,700	e317,100	97,213	458,676
Dimension do	51	8,214	e72	e8,100	60	10,177
Combined value of clays (kaolin), mica (scrap), tripoli (1986-87), and value indicated by symbol W	XX	1,380	XX	1,185	XX	10,871
Total	XX	804,474	XX	843,058	XX	1,016,496

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Pennsylvania in 1986, by county[1]

County	Minerals produced in order of value
Adams	Lime, clays, mica (scrap).
Allegheny	Cement, sand and gravel, clays.
Armstrong	Sand and gravel, clays.
Beaver	Do.
Berks	Cement, clays.
Blair	Sand and gravel.
Bradford	Do.
Bucks	Sand and gravel, clays.
Butler	Lime, cement, sand and gravel.
Cambria	Sand and gravel.
Cameron	Do.
Carbon	Lime, sand and gravel.
Centre	Lime.
Chester	Clays.
Clearfield	Do.
Clinton	Do.
Columbia	Sand and gravel.
Crawford	Do.
Cumberland	Do.
Dauphin	Do.
Erie	Sand and gravel, peat.
Forest	Sand and gravel.
Franklin	Do.
Fulton	Do.
Huntingdon	Do.
Jefferson	Clays, sand and gravel.
Lackawanna	Peat.
Lancaster	Clays.
Lawrence	Cement, sand and gravel, clays.
Lebanon	Lime.
Lehigh	Cement.
Luzerne	Sand and gravel, peat.
Lycoming	Sand and gravel.
Mercer	Do.
Mifflin	Lime, sand and gravel.
Monroe	Sand and gravel, clays, peat.
Montgomery	Lime.
Northampton	Cement, sand and gravel.
Northumberland	Sand and gravel, clays, abrasives.
Pike	Sand and gravel.
Potter	Do.
Schuylkill	Do.
Susquehanna	Do.
Tioga	Do.
Venango	Do.
Warren	Do.
Wayne	Do.
Westmoreland	Do.
Wyoming	Do.
York	Cement, lime, clays.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

In contrast to nonfuel minerals and particularly crushed stone, Pennsylvania's coal and steel industries continued to produce at levels well below those of a decade ago. Coal production of 67 million short tons was the second lowest total in the past 25 years although Pennsylvania remained the Nation's fourth leading producer. Steel production improved slightly to about 12 million tons but was less than one-half the total produced in 1981. Pennsylvania remained the Nation's third leading producer of steel as it has since 1982.

Trends and Developments.—In the 1980's, Pennsylvania's mineral industry began to change from one historically dominated by coal and steel to one increasingly reliant on industrial minerals, in particular, construction aggregate. In 1987, for the first time in State history, crushed stone production surpassed that of coal. The State's construction industry beginning in 1985 became an expanding component of Pennsylvania's rebounding economy whereas the coal and steel industries continued to struggle for a share of the market because of heightened international competition.

Legislation and Government Programs.—The Pennsylvania General Assembly enacted a Non-Coal Surface Mining Conservation and Reclamation Act that included permitting, enforcement, and civil penalty provisions. The State Department of Environmental Resources (DER) began

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developing new regulations to implement the act and was expected to promulgate the regulations in 1988. The act also established a State bonding program for surface mine operators who could not obtain bonds from normal sources such as letters of credit and collateral.

The U.S. Bureau of Mines Pittsburgh Research Center (PRC) continued research programs directed at improving health, safety, and productivity in the mining industries and conserving environmental resources. Mine-scale research was conducted under controlled conditions at facilities including the Experimental Mine, the Safety Research Coal Mine, the Mine Equipment Test Facility, the Wire Rope Laboratory, and the Lake Lynn Laboratory. Research results and plans at PRC are summarized in the publication, "Program of Research."[3]

The Pennsylvania Bureau of Topographic and Geologic Survey was the primary State agency involved in mineral resource investigations. A reconnaissance investigation of potential mica, talc, silica, and carbonate mineral fillers in the Piedmont physiographic province continued. Other economic geology studies included "Reconnaissance for Precious Metals in Southeastern Pennsylvania"; "Chromite and the Massive Chromite from the Wood's Chrome Mine, State-Line District of Pennsylvania-Maryland"; "Investigations and Analysis of High Purity Carbonate Resources in Pennyslvania"; and "Additional Occurrences of Specialty-Use Silica in Pennsylvania." A summary of these and other Survey projects was published.[4]

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Of the 12 nonfuel mineral commodities produced in Pennsylvania and listed in table 1, crushed stone (45%) and portland cement (33%) were the most significant in value of production. Lime and construction sand and gravel accounted for 9% and 7%, respectively, of the total value. The remainder came from output of masonry cement, common clay, kaolin, scrap mica, peat, industrial sand, dimension stone, and tripoli.

Cement.—The State's portland cement industry, predominantly in eastern Pennsylvania, again faced stiff competition from foreign producers. In the last 5 years, cement imports increased from 5% to about 20% of U.S. consumption. A bill to halt use of foreign cement in State-funded construction projects was introduced late in the year and was expected to be acted on in the 1988 legislative session. The measure is similar to Pennsylvania's Steel Products Procurement Act, passed in 1985 because of rising steel imports.

Nationally, about 55% of U.S. cement production capacity was foreign owned. Allentown Portland Cement Co. became the sixth cement plant in Pennsylvania to be acquired by a foreign company. Scancem Industries Inc. of Oslo, Norway, purchased the 830,000-ton-per-year-capacity plant in Evansville for $63.5 million.[5] In 1987, Pennsylvania's 13 cement plants, with about 8.2 million short tons of grinding capacity, were operated at 77% of that capacity.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Pennsylvania's stone industry produced the highest total tonnage ever reported by a State—97 million short tons. Since 1979, when the State produced nearly 72 million tons of crushed stone, output levels had been affected by changing conditions in the construction industry. From 1981 through 1983, interest rates ranged from 12% to 15%, resulting in low levels of construction activity. During that 3-year period, production of crushed stone averaged about 52 million tons annually. Also, in 1985, the State began a 12-year, $11.7 billion highway improvement and construction program, which averaged $1 billion in highway contracts awarded each year through 1987. Housing starts, another indicator of construction industry demand, increased from about 22,000 units in 1982 to about 58,000 units in 1987. In 1984, interest rates began dropping and were below 10% by 1986; crushed stone production increased, averaging 62 million tons per year from 1984 through 1986.

In 1987, 112 companies operated 208 quarries producing 97 million tons of crushed stone. The top 10 producing companies operated 57 quarries and accounted for 46% of the total output. Limestone was the dominant rock type mined; other types included granite, sandstone, and traprock.

In 1985, the U.S. Bureau of Mines began

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compiling crushed stone production statistics by districts for some States. Table 4 presents end-use data for crushed stone in the four Pennsylvania districts that are depicted in figure 1. Production from district 4 in southeastern Pennsylvania accounted for about 70% of the State total. The expanding economy in this district, which includes Philadelphia and Harrisburg, created strong demand for construction aggregate. Of the 19 counties in district 4, 14 reported production in excess of 1 million tons with 6 producing more than 5 million tons.

Table 3.—Pennsylvania: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	795	4,436
Riprap and jetty stone	1,760	8,698
Filter stone	384	1,962
Coarse aggregate, graded:		
Concrete aggregate, coarse	6,114	28,976
Bituminous aggregate, coarse	5,744	25,620
Bituminous surface-treatment aggregate	2,051	10,179
Railroad ballast	903	4,361
Fine aggregate (-3/8 inch):		
Stone sand, concrete	1,949	10,341
Stone sand, bituminous mix and seal	2,276	9,467
Screening, undesignated	1,918	7,593
Coarse and fine aggregates:		
Graded road base or subbase	12,299	51,213
Unpaved road surfacing	1,220	5,311
Terrazzo and exposed aggregate	22	198
Crusher run or fill or waste	2,089	8,555
Other construction[2]	10,949	36,142
Agricultural:		
Agricultural limestone	1,035	9,706
Poultry grit and mineral food	109	1,418
Other agricultrual uses	(3)	(3)
Chemical and metallurgical:		
Cement manufacture	7,473	31,830
Lime manufacture	1,169	7,965
Flux stone	171	752
Special:		
Mine dusting and acid water treatment	85	1,388
Asphalt fillers or extenders	645	5,035
Other fillers and extenders	663	9,733
Other miscellaneous[4]	1,007	7,685
Other unspecified[5]	33,800	167,118
Total[6]	97,213	458,676

[1]Includes limestone, dolomite, sandstone, traprock, granite, quartzite, and miscellaneous stone.
[2]Includes coarse aggregate (graded) and combined coarse and fine aggregates.
[3]Less than 1/2 unit.
[4]Includes dead-burned dolomite, chemical stone for alkali works, sulfur oxide removal, whiting or whiting substitute, roofing granules, glass manufacture, and waste material.
[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[6]Data may not add to totals shown because of independent rounding.

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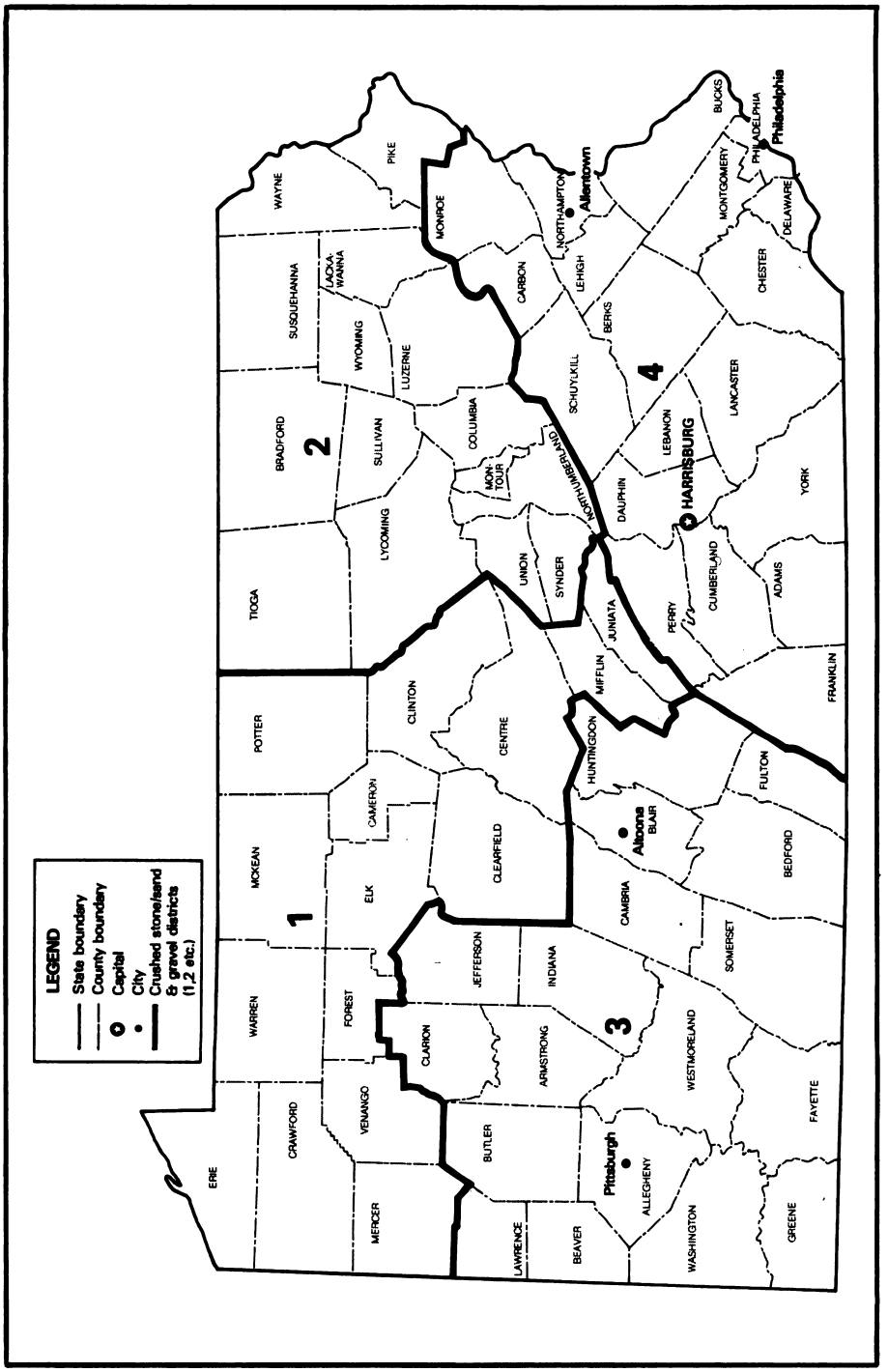

Figure 1.—Aggregate-producing districts in Pennsylvania.

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Table 4.—Pennsylvania: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	430	2,953	129	606	673	4,069	2,287	10,444
Coarse aggregate, graded[2]	908	3,435	931	4,079	2,286	13,107	14,433	60,184
Fine aggregate (-3/8 inch)[3]	726	2,397	525	2,497	1,199	6,586	3,693	15,922
Coarse and fine aggregates[4]	925	3,121	895	3,864	2,068	10,241	15,601	58,365
Other construction	463	2,311	357	1,804	51	218	2,474	9,823
Agricultural[5]	15	257	40	254	36	518	1,053	10,094
Chemical and metallurgical[6]	1,111	8,083	1	7	1,445	7,224	6,797	30,239
Special[7]	W	W	7	88	W	W	1,599	16,075
Other miscellaneous	41	432	--	--	182	2,093	32	168
Other unspecified[8]	233	1,049	1,929	9,901	10,562	53,503	21,076	102,665
Total[9]	4,851	24,037	4,814	23,099	18,503	97,560	69,046	313,979

W Withheld to avoid disclosing company proprietary data; included with "Other unspecified."

[1]Includes macadam, riprap and jetty stone, and filter stone.

[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, and coarse aggregate (graded).

[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screen).

[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, crusher run or fill or waste, and combined coarse and fine aggregates.

[5]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.

[6]Includes cement manufacture, lime manufacture, dead-burned dolomite, flux stone, chemical stone for alkali works, glass manufacture, and sulfur oxide removal.

[7]Includes mine dusting, asphalt filler, whiting or whiting substitute, other fillers or extenders, roofing granules, and waste material.

[8]Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

[9]Data may not add to totals shown because of independent rounding.

Other Industrial Minerals.—Masonry cement was produced at 10 plants in Pennsylvania in 1987. Output of nearly 400,000 short tons ranked the State second nationally and accounted for about 11% of the U.S. total. Common clay was produced at 26 mines and pits; fire clay at 2 and kaolin at 1. Output of common clay and kaolin remained about the same as in 1986; fire clay production dropped by about 48% as demand from the steel industry continued to decline. Lime production increased by about 11% and the State ranked third nationally in output. Bethlehem Steel Corp. sold its lime plants and limestone quarries in Hanover and Millard to Broyhill & Associates Inc. Mica (scrap) was mined from an open pit near Fairfield, Adams County, by one producer. Peat was produced by eight companies with bogs in Erie, Lackawanna, Luzerne, and Monroe Counties. Industrial sand was produced by two companies; one in Allegheny County, the other in Huntingdon County. Dimension stone was produced at 17 quarries by 12 companies. Tripoli was produced by one company in Northumberland County.

Table 5.—Pennsylvania: Lime sold and used by producers, by use

Use	1986		1987	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Agriculture	57,691	$3,135	35,541	$1,811
Acid water neutralization	11,639	762	15,914	1,022
Paper and pulp	25,779	1,265	W	W
Steel, basic oxygen furnace	569,221	28,847	W	W
Steel, electric	146,770	7,007	132,503	6,057
Sewage treatment	107,790	6,131	90,211	5,062
Water purification	64,514	3,720	45,830	2,624
Other[1]	433,897	30,367	1,254,015	76,854
Total	1,417,301	81,234	1,574,014	93,430

W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes alkalies, briquetting explosives, glass (1986), industrial soil waste, ladle desulfurization, open-hearth steel, ore concentration, other chemical and industrial, other metallurgy, other stabilization, paint, petroleum refining, road stabilization, refractory shapes, sand-lime brick, silica brick, soil stabilization, sugar refining, sulfur removal, tanning, wire drawing; and data indicated by symbol W.

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METALS

Metals discussed in this section were processed from materials received from both foreign and domestic sources. Production and value data for these commodities, which are not included in table 1, are given, if available. No metals were mined in Pennsylvania.

Iron and Steel.—Pennsylvania ranked third among 10 States producing pig iron; shipments in 1987 totaled about 5.1 million short tons valued at $1.1 billion. Steel production was about 11.7 million tons and the State also ranked third nationally in output of that commodity. Production of pig iron and steel in 1986 was 4.5 million tons and 9.5 million tons, respectively.

A labor strike at USX Corp. halted production from August 1986 until February 1987. The contract settling the 6-month strike at USX reduced labor cost by about $2.00 per hour. The union received a profit-sharing plan and a company commitment to modernize some plants.

Installation of a continuous caster at the Edgar Thomson plant near Braddock was part of the agreement. The caster would be the first installed by USX in Pennsylvania; nationwide, the firm continuously cast about 60% to 65% of its steel, about the same proportion as the domestic steel industry as a whole. In contrast, about 97% of Japan's steel was continuously cast. USX also agreed not to close the open-hearth furnaces at its Fairless, PA, plant for the length of the contract, which would expire in February 1991.

By the fourth quarter, steel producers in Pennsylvania and throughout the United States were beginning to benefit from the dollar's lower foreign-exchange rate. This brought the price of some domestic steel in line with prices in the international market. USX reactivated its export unit in Pittsburgh to expand opportunities to compete with foreign steelmakers. The unit had been disbanded in 1984.

Bethlehem Steel Corp. operated three of its five raw-steel-producing facilities in Pennsylvania at Bethlehem, Johnstown, and Steelton. In 1987, Bethlehem utilized 72% of 16 million tons of steelmaking capability; about one-third of the firm's steelmaking capability was at its three Pennsylvania plants.

Zinc.—Although zinc is no longer mined in Pennsylvania, smelting operations continued at Monaca and Palmerton. In September, Horsehead Industries Inc. (HII) became the Nation's largest zinc producer with the purchase of St. Joe Resources Co., a transaction that included St. Joe's Monaca smelter. HII, the parent of New Jersey Zinc Co. Inc., which operates the Palmerton smelter, combined that operation with those previously owned by St. Joe to form a new company called Zinc Corp. of America. The move was expected to increase the efficiency of the smelters in Pennsylvania.

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[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]Economic geologist, Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, PA.
[3]U.S. Bureau of Mines. Program of Research. Pittsburgh Research Center, Cochrans Mill Rd., Box 18070, Pittsburgh, PA 15236.
[4]Pennsylvania Geology. Bureau of Topographic and Geologic Survey. V. 19, No. 4, Aug. 1988, 32 pp.
[5]The Morning Call (Allentown, PA). Allentown Cement Plant To Get Foreign Owner. Dec. 10, 1987, p. 4.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Coplay Cement Co	Drawer 32 Nazareth, PA 18064	Plant and quarries.	Lehigh and Northampton.
General Portland Inc	5160 Main St. Whitehall, PA 18052	Plant	Lehigh.
Hercules Cement Co	Center St. Stockertown, PA 18083	Plant and quarry.	Northampton.
Lone Star Industries Inc	Wood & Prospect St. Box 270 Nazareth, PA 18064	Plant	Do.
Clays:			
L. D. Baumgardner Coal Co. Inc	Box 127 Lanse, PA 16849	Pit	Clearfield.
Glen-Gery Corp	Box 1542 Reading, PA 19603	Pits and plant	Adams, Berks, York.
Medusa Corp	Box 5668 Cleveland, OH 44101	Pit	Lawrence.
Lime:			
Bethlehem Steel Corp.[1]	Martin Tower Bethlehem, PA 18016	Plants and quarries.	Adams and Lebanon.
Mercer Lime & Stone Co	525 William Penn Pl. Pittsburgh, PA 15219	Plant	Butler.
Warner Co	Yellow Springs Rd. Devault, PA 19432	Plant, mine, quarries.	Centre and Chester.

See footnote at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Peat:			
Gouldsboro Wayne Peat Co	Box 68 Gouldsboro, PA 18424	Bog	Lackawanna.
Lake Benton Peat Moss	622 South Blakely St. Dunmore, PA 18512	Bog	Do.
Sand and gravel:			
Construction:			
Davison Sand & Gravel Co	Third Ave. and Fourth St. New Kensington, PA 15068	Dredge and pits.	Armstrong and Westmoreland.
Dravo Corp	4800 Grand Ave. Pittsburgh, PA 15222	Dredge, pit, plant.	Allegheny and Beaver.
Glacial Sand & Gravel Co	Box 1022 Kittanning, PA 16201	____do ___	Armstrong.
Stabler Co. Inc.[1]	Box 8188 Wescoville, PA 18106	Pits and plants.	Bradford and Northampton.
Warner Co	699 Bristol Pike Morrisville, PA 19067	Pit and plant	Bucks.
Wyoming Sand & Stone Co	R.D. 1 Falls, PA 18615	____do ___	Wyoming.
Industrial:			
McCrady Inc	Box 11566 Pittsburgh, PA 15238	Quarries and plant.	Allegheny.
U.S. Silica Co	Box 187 Berkeley Springs, WV 25411	____do ___	Huntingdon.
Stone:			
Crushed:			
The General Crushed Stone Co., a subsidiary of Koppers Co. Inc.	Box 231 Easton, PA 18042	____do ___	Berks, Bucks, Chester, Clinton, Columbia, Dauphin, Delaware, Lancaster, Montour, Tioga, York.
New Enterprise Stone & Lime Co. Inc.	R.D. 3 New Enterprise, PA 16664	____do ___	Adams, Bedford, Blair, Cumberland, Franklin, Huntingdon, Lancaster, Somerset.
Dimension:			
A. Dally & Sons Inc	Railroad Ave., Box 27 Pen Argyl, PA 18072	Quarries and mills.	Northampton.
Delaware Quarries	Route 32 Lumberville, PA 18933	Quarry____	Bucks.
Pennsylvania Granite Corp	Box 510 St. Peters, PA 19470	____do ___	Chester.

[1]Also stone.

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The Mineral Industry of Puerto Rico and Caribbean and Pacific Island Possessions

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Department of Natural Resources, Commonwealth of Puerto Rico, for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and Ivette E. Torres[2]

PUERTO RICO

In 1987, the value of nonfuel mineral commodities produced in Puerto Rico totaled $152 million, an increase of $28 million over that of 1986. Most of the island's mineral output, cement, clays, sand and gravel, and stone, was sold in Puerto Rico.

Table 1.—Mineral production[1] in Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1985		1986		1987	
	Quantity	Value	Quantity	Value	Quantity	Value
Cement (portland)	962	$72,602	W	W	1,296	$106,185
Clays	118	264	111	$223	148	318
Lime	23	3,249	24	3,291	25	3,558
Salt	35	735	40	880	40	900
Sand and gravel (industrial)	--	--	31	624	67	W
Stone:						
Crushed	5,493	25,799	e5,400	e26,000	8,480	41,299
Dimension	W	W	--	--	--	--
Total[2]	XX	102,649	XX	31,018	XX	152,260

eEstimated. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Total does not include value of items not available or withheld.

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Table 2.—Nonfuel minerals produced in Puerto Rico in 1986, by district[1]

District	Minerals produced in order of value
Mayagüez	Sand and gravel (industrial).
Ponce	Cement, clays.
San Juan	Cement, lime, clays.
Undistributed[2]	Stone (crushed), salt.

[1]No production of nonfuel mineral commodities was reported for districts not listed.
[2]Data not available by district for minerals listed.

Trends and Developments.—Puerto Rico's construction industry is the major market for the commodities produced by the island's mineral industry. Despite continuing problems with a shortage of skilled labor, slow Government procedures for issuing construction permits, and the lack of water and sewer capacity, construction investment in FY 1987 was the highest since 1981.[3] Public construction investment was approximately $180 million (1984 dollars) and private investment topped $150 million (1984 dollars) for the first time since 1979.

Legislation and Government Programs.—The U.S. Corps of Engineers let contracts for test borings along the Puerto Nuero River as part of a $246 million flood control project. The project will include 17 kilometers of "high velocity, reinforced concrete channels, 2 debris basins, and replacement of 22 bridges." Construction is scheduled to begin in 1991. When completed, the floodway is expected to open thousands of acres of "flood-prone" land for urban development.[4]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals—*Cement.*—Puerto Rican Cement Co. Inc. in Ponce, and San Juan Cement Co. near San Juan comprise the island's cement industry. During the year both companies worked to complete feasibility studies for converting the two facilities to the dry-cement-manufacturing process. Puerto Rican Cement will begin plant conversion, a $30 million project, in 1988.

Clays.—The two cement companies and several clay products manufacturers mined clay. The cement companies used clay in clinker manufacture, while the clay products companies produced brick and tile.

Graphite.—Union Carbide P.R. Inc. announced that it would close its Yabucoa plant in March 1988 because of a slump in the demand for synthetic graphite electrodes.

Lime.—Puerto Rican Cement Co. Inc. produced chemical-grade lime at its Ponce plant.

Salt.—Two companies produced salt by solar evaporating of seawater. Pharmaceutical and petrochemical producers, tuna packers, sugar mills, and curing and tanning plants were the major markets.

Sand and Gravel (Industrial).—Several stone companies produced a sand-size material as a coproduct of stone crushing; this material was used as construction aggregate. Owens-Illinois de Puerto Rico produced an industrial sand for bottle manufacture at a site near Vega Alte.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered

Table 3.—Puerto Rico: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	53	266
Coarse aggregate, graded: Concrete aggregate, coarse	427	2,419
Fine aggregate (-3/8 inch): Stone sand, concrete	775	3,688
Coarse and fine aggregates:		
Terrazzo and exposed aggregate	95	742
Other construction[2]	1,925	9,663
Agricultural: Poultry grit and mineral food	70	651
Chemical and metallurgical: Cement manufacture	1,821	6,248
Other miscellaneous:[3]	8	61
Other unspecified:[4]	3,305	17,560
Total[5]	8,480	41,299

[1]Includes limestone, marble, sandstone, granite, traprock, and miscellaneous stone.
[2]Includes macadam, filter stone, coarse aggregate (graded), bituminous aggregate (coarse), bituminous surface-treatment aggregate, fine aggregate, stone sand (bituminous mix or seal), screening (undesignated), graded road base or subbase, unpaved road surfacing, and crusher run or fill.
[3]Includes other agricultural and other fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

U.S. Mine Safety and Health Administration records indicate that crushed stone was produced at 53 quarries in all 7 of the island districts during 1987.

Metals.—General Chemical Corp. purchased bauxite from Guyana as plant feed for an alum plant in Vega Alta. Alum was processed into liquid aluminum sulfate for use in water treatment. General Chemical, a subsidiary of Henley Manufacturing Inc., purchases approximately 7,000 short tons of bauxite annually. The 40-employee plant was established in 1973.

U.S. CARIBBEAN ISLAND POSSESSIONS

The Virgin Islands was the only Caribbean island possession with mineral production. Output was limited to crushed stone and sand.

PACIFIC ISLAND POSSESSIONS

Stone is the only mineral commodity reported from Guam and American Samoa, two of the Pacific island possessions.

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[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

[2]Program specialist, Minerals Information, Washington, DC.

[3]Caribbean Business. Persisting Problems Confront Construction Contractor. June 30, 1988.

[4]———. Borings Begin on $246 M Corps Project. Nov. 19, 1987.

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The Mineral Industry of Rhode Island

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Rhode Island Department of Environmental Management for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production was $18.7 million, an increase of nearly 32% over that of 1986. Sand and gravel and crushed stone were the only two mineral commodities produced. Increases in construction sand and gravel value and crushed stone, 32% and 37% respectively, closely paralleled the increases reported by the construction industry, which depended heavily on the availability of both of these commodities. According to F. W. Dodge Corp., the value of contracts for residential construction increased 29% over that of 1986. Increases were also reported for nonresidential construction (33%) and public works and utilities (42%). Although there were only 174 persons employed by the mining industry in 1987, wages generated during the year amounted to nearly $4.5 million. Employment by the mineral dependent construction industry totaled 19,608 persons with wages of $447 million.

Table 1.—Nonfuel mineral production in Rhode Island[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	W	NA	W	NA	$1
Sand and gravel:						
Construction thousand short tons	e1,200	e$4,600	2,269	$8,252	e2,700	e10,900
Industrial do.	W	W	22	143	W	W
Stone (crushed) do.	21,135	27,016	e 21,000	e 25,700	1,228	7,797
Combined value of other industrial minerals and values indicated by symbol W	XX	576	XX	101	XX	(3)
Total	XX	12,192	XX	14,196	XX	418,698

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; value included with "Combined value" figure.
[3]Value excluded to avoid disclosing company proprietary data.
[4]Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

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Table 2.—Nonfuel minerals produced in Rhode Island in 1986, by county[1]

County	Minerals produced in order of value
Kent	Sand and gravel.
Providence	Sand and gravel (industrial).
Washington	Sand and gravel.
Undistributed[2]	Stone (crushed and broken), miscellaneous stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for regions not listed.
[2]Data not available by counties for minerals listed.

Legislation and Government Programs.—During fiscal year 1988, the Rhode Island Office of State Planning, a division of the Department of Administration, completed most of the draft text of the land use plan update entitled "Land Use 2010." Topics addressed included acid rain, air quality, earthquakes, energy resources, geology, minerals, topography, and water resources. Technical papers published during 1987 included Housing & Residential Land Demand (No. 129) and Land Use Controls: A Working Paper for Land Use—2010 (No. 131).

In July, the Secretary of the Department of the Interior gave final approval to the Federal offshore oil- and gas-leasing program for July 1987 through July 1992. Rhode Island will be affected by three lease sales: No. 96 (North Atlantic, February 1989), No. 121 (Mid-Atlantic, October 1989), and No. 134 (North Atlantic, February 1992).

In August, the U.S. Environmental Protection Agency (EPA) and the State Department of Environmental Management announced that cleanup work was under way at the Western Sand and Gravel Hazardous Waste Site in Nasonville. Construction was started on an impermeable cap, one layer made of high-density plastic and the other of clay, to stop the spread of the contamination. The "Superfund" site is a former sand and gravel pit where liquid wastes, chemicals, and septage were dumped into unlined lagoons and pits in the late 1970's. The wastes infiltrated the soil and contaminated the ground water.

The U.S. Bureau of Mines tried to determine whether use of certain drilling fluid additives enhanced bit penetration rates and extended bit life. The Bureau conducted tests on three different rock types, one of which was from Rhode Island. The three rock types chosen were the Westerly granite (Rhode Island), taconite (Minnesota), and the Sioux quartzite (Minnesota). For the Westerly granite, penetration increases of 155% and 165% were obtained when drilling with aluminum chloride solutions. Maximum bit life extensions of 109% and 136% were also achieved. Additional details concerning the drilling fluid additive tests on the samples are available in a Bureau of Mines report.[2]

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Based on these estimates, output and value of construction sand and gravel increased 19% and 32%, respectively, compared with those of 1986. In 1986, 14 companies operated 16 pits in 3 counties. Leading counties in order of output were Kent, Providence, and Washington. Construction sand and gravel was used principally for concrete aggregate, asphaltic concrete aggregate, road base and coverings, and fill.

Industrial.—Holliston Sand Co. Inc., Providence County, was the only industrial sand producer in the State. Most of the sand was used for filtration, blasting, golf course sand, and molding and core.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed stone production totaled 1.2 million short tons valued at $7.8 million, a 23% increase in tonnage and 37% increase in value. In 1987, four companies operated four quarries in Providence County and one operated in Newport County. Most of the stone was used for bituminous aggregate, filter stone, surface treatment, and riprap.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]Engelmann, W. H., P. J. Watson, P. A. Tuzinski, and J. E. Pahlman. Zeta Potential Control for Simultaneous Enhancement of Penetration Rates and Bit Life in Rock Drilling. BuMines RI 9103, 1987, 18 pp.

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Table 3.—Rhode Island: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	38	W
Filter stone	128	W
Coarse aggregate, graded:		
Concrete aggregate, graded	20	W
Bituminous aggregate, coarse	133	W
Bituminous surface-treatment aggregate	100	W
Fine aggregate (-3/8 inch):		
Stone sand, concrete	63	W
Stone sand, bituminous mix and seal	29	W
Coarse and fine aggregates: Graded road base or subbase	23	W
Agricultural: Agricultural limestone	16	W
Other unspecified[2]	678	4,367
Total	1,228	7,797

W Withheld to avoid disclosing individual company proprietary data; included in "Total."
[1]Includes limestone, granite, and traprock.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Sand and gravel (1986):			
A. Cardi Construction Co. Inc	451 Arnold Rd. Coventry, RI 02816	Pits and plant	Kent.
Holliston Sand Co.[1]	Box 393 Slatersville, RI 02876	Pit and plant	Providence.
River Sand & Gravel Co. Inc	101 Ferris St. Pawtucket, RI 02861	Pit	Kent.
South County Sand & Gravel Co	North Rd. Peace Dale, RI 02878	Pit and plant	Washington.
TASCA Sand & Gravel Co	Log Rd. Smithfield, RI 02917	Pit	Providence.
Stone:			
The Conklin Limestone Co	R.F.D. 1 Lincoln, RI 02865	Quarry	Do.
Forte Bros. Inc	14 Whipple St. Berkley, RI 02864	do	Do.
J. H. Lynch & Sons Inc.[2]	825 Mendon Rd. Cumberland, RI 02864	do	Do.
Peckham Brothers Co. Inc	Box 193 Newport, RI 02840	do	Newport.
Tilcon Inc	875 Phoenix Ave. Cranston, RI 02920	do	Providence.

[1]Also industrial sand.
[2]Also sand and gravel.

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The Mineral Industry of South Carolina

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey, State Division of Research and Statistical Services, for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and Arthur H. Maybin[2]

The value of South Carolina's mineral output in 1987 was $341 million, a $45 million increase over 1986 output and a new State record. Value increased for 11 of the 16 mineral commodities extracted. Value fell for construction sand and gravel, dimension stone, masonry cement, peat, and silver below those of the previous year. Although value fell, construction sand and gravel and masonry cement production exceeded the 1986 output.

The record value for 1987 was mainly the result of increased output and increased unit value for crushed stone.

During the year, the State's second gold mine began operations and a third received the necessary State permits to begin operation. A citizens group appealed the issuance of the permits, and the company was required to wait until the appeal was settled before beginning construction. The company sued the State to begin construction; the suit was unresolved at yearend.

Table 1.—Nonfuel mineral production in South Carolina[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) thousand short tons	2,207	$104,705	2,306	$109,529	2,567	$117,878
Clays[2] do.	1,896	37,695	1,986	37,980	2,193	38,244
Gem stones	NA	e10	NA	10	NA	10
Manganiferous ore short tons	19,882	W	14,320	W	19,087	W
Peat thousand short tons	W	173	W	W	W	W
Sand and gravel:						
Construction do.	e4,900	e14,000	7,200	19,783	e7,500	e19,500
Industrial do.	794	14,092	800	14,081	844	15,188
Stone:						
Crushed do.	17,079	72,520	e18,200	e76,700	[3]24,278	[3]105,387
Dimension do.	8	541	e8	e533	2	312
Combined value of cement (masonry), clays (fuller's earth), gold, mica (scrap), silver, stone (crushed shell, 1987), vermiculite, and values indicated by symbol W	XX	32,193	XX	37,273	XX	44,806
Total	XX	275,929	XX	295,889	XX	341,325

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in South Carolina in 1986, by county[1]

County	Minerals produced in order of value
Aiken	Clays, sand and gravel.
Bamberg	Sand and gravel.
Berkeley	Do.
Calhoun	Clays.
Charleston	Sand and gravel.
Cherokee	Clays, sand and gravel, manganese.
Chesterfield	Sand and gravel.
Colleton	Peat, sand and gravel.
Dillion	Sand and gravel.
Dorchester	Cement, sand and gravel, clays.
Edgefield	Clays.
Florence	Sand and gravel.
Greenville	Do.
Greenwood	Clays.
Horry	Sand and gravel, clays.
Jasper	Sand and gravel.
Kershaw	Do.
Lancaster	Gold, sand and gravel, mica, clays, silver.
Laurens	Vermiculite, sand and gravel.
Lee	Sand and gravel.
Lexington	Sand and gravel, clays.
Marion	Clays.
Marlboro	Sand and gravel, clays.
Orangeburg	Cement, clays, sand and gravel.
Richland	Clays, sand and gravel.
Saluda	Clays, manganese.
Spartanburg	Sand and gravel.
Sumter	Sand and gravel, clays.
Union	Sand and gravel.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

The industrial minerals sector of South Carolina's extractive mineral industry produced 13 mineral commodities.

Cement.—Portland cement production accounted for almost 35% of the State's mineral value, and South Carolina's cement industry ranked ninth nationally in output and value. The $8 million increase in sales over the 1986 level was due to the strong construction activity throughout many areas of the State.

The State's three cement companies, in Dorchester and Orangeburg Counties, produced Portland Types I and II. Two of these companies, Giant Portland & Masonry Cement Co. and Santee Portland Cement Co., also produced masonry cement. Raw materials were both mined locally and imported from Canada and the Caribbean area.

Clays.—South Carolina ranked seventh of the 44 clay-producing States, and clay output, excluding fuller's earth, accounted for 11% of the State's mineral value. Both kaolin and common clay-phyllite were mined.

Kaolin.—The production of kaolin accounted for 97% of South Carolina's clay production. Production was from a belt extending from the south-central part of the State to east-central Georgia. Industrial kaolin production was reported by five companies operating eight surface mines in Aiken County. Brick-grade kaolin was mined by 7 companies from 13 mines in 6 counties. Production of both grades decreased 250,000 short tons from the amount reported in 1986.

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Table 3.—South Carolina: Kaolin sold or used by producers, by kind and use

(Short tons)

Kind and use	1986	1987
Air-float:		
Adhesives	17,483	18,208
Animal feed and pet waste absorbent	3,603	3,459
Ceramics[1]	3,637	2,896
Fertilizers, pesticides and related products	6,732	20,308
Fiberglass	99,393	143,498
Paint	580	332
Paper coating and filling	8,644	18,547
Plastics	9,581	9,142
Rubber	235,142	194,283
Refractories[2]	5,693	6,073
Other uses[3]	82,743	63,970
Exports[4]	33,474	56,400
Total	506,705	537,116
Unprocessed: Face brick and other uses	556,383	272,344
Grand total	1,063,088	809,460

[1]Includes floor and wall tile, pottery, and roofing granules.
[2]Includes refractory calcines and grogs; refractory mortar and cement; high-alumina refractories; and firebrick, blocks, and shapes.
[3]Includes animal oil; catalysts (oil-refining); chemical manufacturing; ink, medical; sewer pipe; and unknown uses.
[4]Includes ceramics, adhesives, paper filling, pesticides and related products, and rubber.

Common Clay.—The production of common clay-phyllite accounted for 3% of the State's total clay output. This was an increase of $335,000 over the 1986 value, due to the increased demand for brick and other clay products used by the construction industry.

Mica.—The Mineral Mining Corp. (Minco) mined sericite from a deposit adjacent to the Haile Gold Mine near Kershaw in Lancaster County. Crude ore was trucked to the Minco plant northeast of Kershaw for dry grinding and bagging. Sales were to the paint industry in the United States and Canada.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel accounted for 6% of the State's total mineral production value. Production increased 300,000 short tons in 1987, a result of the continued strong showing of the South Carolina construction industry.

Industrial.—Sand for industrial applications, primarily glass and fiberglass manufacture, was produced by six companies operating six mines in Lexington (three mines), Kershaw (two mines), and Cherokee (one mine) Counties.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—The value of crushed stone accounted for 31% of the State's mineral output. Stone sales rose $28 million in 1987, the result of the strong demand for new housing and other construction projects. In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 5 presents end-use data for crushed stone produced in the three South Carolina districts depicted in figure 1.

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Table 4.—South Carolina: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	662	3,097
Riprap and jetty stone	245	1,348
Coarse aggregate, graded:		
Concrete aggregate, coarse	3,711	19,668
Bituminous aggregate, coarse	1,975	10,118
Bituminous surface-treatment aggregate	467	2,520
Railroad ballast	408	2,107
Fine aggregate (-3/8 inch):		
Stone sand, concrete	322	893
Stone sand, bituminous mix and seal	1,131	5,038
Screening undesignated	1,614	5,478
Coarse and fine aggregates:		
Graded road base or subbase	2,261	7,257
Unpaved road surfacing	417	1,867
Crusher run or fill or waste	2,856	17,860
Other construction[2]	2,208	12,013
Special: Other miscellaneous[3]	3,638	8,115
Other unspecified[4]	1,364	8,009
Total[5]	24,278	105,387

[1]Includes limestone, granite, marl; a minor amount of shell withheld to avoid disclosing company propriatary data.
[2]Includes terrazzo and exposed aggregate.
[3]Includes agricultural limestone, cement manufacture, and sulfur oxide removal.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

Table 5.—South Carolina: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (1+1/2 inch)[1]	513	2,419	W	W	W	W
Coarse aggregate, graded[2]	2,502	13,327	W	W	W	W
Fine aggregate (-3/8 inch)[3]	2,015	7,619	W	W	W	W
Coarse and fine aggregates[4]	2,911	13,233	W	W	W	W
Other construction	1,033	6,382	5,490	28,622	4,813	17,662
Agricultural[5]	(6)	(6)	--	--	(6)	(6)
Chemical and metallurgical[7]	--	--	(6)	(6)	(6)	(6)
Other miscellaneous	276	1,966	1,648	2,831	1,714	3,317
Other unspecified[8]	943	4,587	421	3,472	--	--
Total[9]	10,193	49,484	7,559	34,925	6,527	20,978

W Withheld to avoid disclosing individual company proprietary data; included with "Other construction."
[1]Includes macadam and riprap and jetty stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screen).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[5]Includes agricultural limestone.
[6]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[7]Includes cement manufacture and sulfur oxide removal.
[8]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[9]Data may not add to totals shown because of independent rounding.

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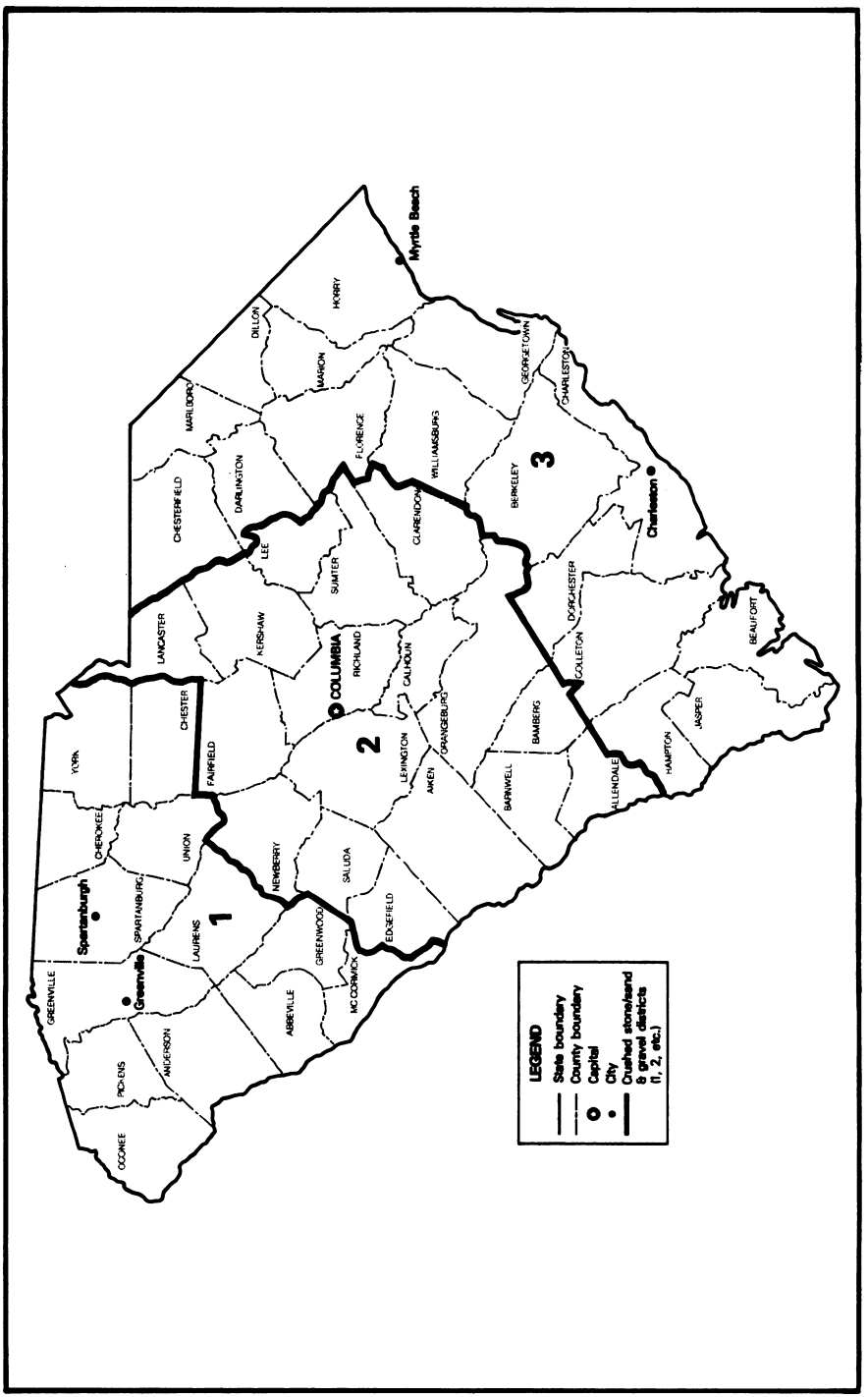

Figure 1.—Aggregate-producing districts in South Carolina.

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Dimension.—Granite blocks were quarried by five companies operating eight quarries in Kershaw and Lancaster Counties. Some of the blocks were shipped to Elberton, GA, for finishing.

Vermiculite.—South Carolina ranked first nationally in vermiculite concentrate output. Three exfoliation plants were in operation in Laurens County, two owned by W. R. Grace and Co. and one by Patterson Vermiculite. South Carolina Vermiculite Co. operated a beneficiation plant near Woodruff.

Major sales were for lightweight aggregate applications, loose fill insulation, and horticultural uses.

Other Industrial Minerals.—Several industrial minerals were shipped into the State for grinding or manufacture into higher valued products. Fiberglass companies in North and South Carolina imported calcium borate minerals, primarily Turkish colemanite and ulexite, for use in fiberglass manufacture. The borate minerals were processed by Industrial Minerals Inc. in a custom grinding plant at Kings Creek in Cherokee County. Spartan Minerals Corp. operated a custom feldspar-silica grinding plant at Pacolet. The company, a subsidiary of Lithium Corp. of America (Lithco), ground a concentrate recovered during lithium ore beneficiation at Cherryville, NC. Primary sales were to the glass and whiteware industries. Amoco Performance Products, Greenville, and Airco Carbon South Carolina Works, a division of BOC, Ridgeville, comprised South Carolina's synthetic graphite industry. Union Carbide's 1-million-pound-per-year plant produced graphite fiber, while the Airco facility produced electric arc furnace electrodes in four different diameters in 60- to 110-inch lengths. Spartan Minerals, Pacelot, dry ground mica recovered during lithium beneficiation at Lithco's Cherryville, NC, operation. The joint compound industry was the principal market. Steel slag from South Carolina's three minimills was marketed for aggregate applications. Slag from the Macalloy chrome ferroalloy plant in Charleston was marketed as an aggregate, a refractory material, and for roofing-shingle applications.

METALS

Aluminum.—Alumax Inc. operated an aluminum smelter at Mount Holly in Berkeley County, the only aluminum smelter in South Carolina. The 181,000-metric-ton facility housed two potlines and produced billets, ingots, and slabs. The smelter feed was alumina imported from Australia. In December, Alumax sold a 26.67% share in the company to Clarendon Ltd. of Zug, Switzerland.[3]

Copper.—A copper recycling facility was operated by AT&T Nassau Metals Corp. at Gaston. The facility contained a scrap handling and upgrading section, a three-story secondary smelter, an electrolytic refinery, and a continuous cast copper wire plant.

Ferroalloys.—Macalloy operated the only significant domestic 50% to 55% charge chrome ferroalloy plant. The Charleston facility included two furnaces with power ratings of 36,0000 and 40,000 kilowatts. Feed for the facility was obtained from the General Services Administration (GSA) stockpile in Montana and from foreign sources. The company signed a $65 million, 2-year contract with GSA to upgrade stockpile chromite to ferrochrome.

Germanium.—Pirelli Cable Corp. of Union, NJ, operated a fiber optic cable manufacturing facility near Lexington. A germanium compound was the major constituent in the optical fibers.

Gold.—During the year the State's second gold producer came on-stream. Joining Piedmont Mining Co. was the Brewer Gold Co., a subsidiary of Westmont Mining Inc. Brewer Mining was developing the old Brewer Mine west of Jefferson, and the first gold pour was in the summer of 1987. Like Piedmont's Haile Mine, the Brewer Mine used the heap-leach gold extraction process.

Ridgeway Mining Co., a subsidiary of Amselco Minerals Ltd., a subsidiary of British Petroleum, and Galactic Resources Ltd. of Canada, received all necessary Federal and State permits to construct a vat-leach recovery system and to begin mining twin gold ore bodies at a property in Fairfield County, approximately 20 miles north of Columbia. A citizens group appealed the permits, and the State ruled that the mining company must wait until settlement of the permit controversy before beginning work on the plant and minesites. The mining company then sued the State to gain permission to begin work. The citizens group entered the suit on the side of the State, and a series of hearings were conducted during the latter part of the year. At yearend, the permit controversy remained unresolved.

Manganiferous Ore.—A manganiferous-rich material was produced from surface

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mines in the Battleground Schist and used for brick coloring. Five companies produced the material in Cherokee County in the northern part of the State.

Platinum.—Engelhard Corp. completed a custom catalyst plant near Seneca. The plant used palladium, platinum, rhodium, and ruthenium to produce catalysts for the automobile, chemical, film, and petroleum industries.

Silver.—Coproduct silver was recovered during the refining of doré bullion from the Haile Mine near Kershaw and from the Brewer Mine near Jefferson. Silver comprised approximately 30% of the bullion generated at the mines.

Zircon.—M&T Chemicals Inc. operated a zircon grinding plant at Andrews. Australian and Florida zircon concentrates, recovered during titanium mineral beneficiation, were used as plant feed. Ground zircon was marketed to the ceramics, foundry, wall tile, and whiteware industries.

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[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

[2]Chief, Mineral Resources, South Carolina Geological Survey, Columbia, SC.

[3]American Metals Market. Balanced Capacity in Smelting, Fabricating, Sought by Alumax. V. 96, No. 88, May 5, 1988.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum (smelters):			
Alumax Inc	Box 1000 Goose Creek, SC 29445	Plant	Berkeley.
Cement:			
Giant Portland & Masonry Cement Co.	Box 218 Harleyville, SC 29448	do	Dorchester.
Gifford-Hill & Co. Inc	Box 326 Harleyville, SC 29448	do	Do.
Santee Portland Cement Co	Box 698 Holly Hill, SC 29059	do	Orangeburg.
Clays:			
Common clay and shale:			
Gifford-Hill & Co. Inc	Box 326 Harleyville, SC 29448	Mines and plant	Dorchester.
Palmetto Brick Co.[1]	Box 430 Cheraw, SC 29520	do	Chesterfield and Marlboro.
Richtex Corp.[1]	Box 3307 Columbia, SC 29230	do	Lexington and Richland.
Santee Portland Cement Co	Box 698 Holly Hill, SC 29059	do	Orangeburg.
Southern Brick Co	Box 208 Ninety Six, SC 29666	do	Greenwood, Newberry, Saluda.
Kaolin:			
Cyprus Industrial Minerals Co	7000 South Yosemite St. Englewood, CO 80155	do	Aiken.
W. R. Grace & Co., a subsidary of National Kaolin Products Co.	Box 2768 Aiken, SC 29802	do	Do.
J. M. Huber Corp	Route 4 Huber Macon, GA 31298	do	Do.
Richtex Corp	Box 3307 Columbia, SC 29230	do	Lexington and Richland.
Colemanite:			
Industrial Minerals Inc	Box 459 York, SC 29745	Plant	York.
Feldspar:			
Spartan Minerals Corp., a subsidiary of Lithium Corp. of America.	Box 520 Pacolet, SC 29372	do	Spartanburg.
Manganiferous ore:			
Ashe Brick Co	Van Wyck, SC 29744	Mine and plant	Do.
Broad River Brick Co., a division of Borden Clay Products Co.	Box 368 Pleasant Garden, NC 27313	do	Do.
Fletcher Brick Co., a division of Moland-Drysdale Corp.	Box 2150 Hendersonville, NC 28739	do	Do.
Mica (sericite):			
Mineral Mining Corp	Box 458 Kershaw, SC 29067	do	Lancaster.
Sand and gravel:			
Becker Sand and Gravel Co. Inc	Box 848 Cheraw, SC 29520	Pits and plants	Chesterfield, Dorchester, Florence, Marlboro, Sumter.
Brewer Sand Co. Inc	Box 267, Route 2 Lancaster, SC 29720	Pit and plant	Lancaster.
Foster-Dixiana Sand Co	Box 5447 Columbia, SC 29250	do	Lexington.

See footnote at end of table.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Granite:			
Crushed:			
Lone Star Industries Inc	515 West Greens Rd. Houston, TX 77067	Quarries and plant.	Fairfield, Greenwood, Richland.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27612	do	Fairfield, Lexington, Richland, York.
Vulcan Materials Co	Box 7497 Birmingham, AL 35253	do	Greenville, Laurens, Pickens, Spartanburg.
Dimension:			
Granite Panelwall Co., a division of Florida Crushed Stone Co.	Box 898 Elberton, GA 30635	Quarry	Kershaw.
Matthews International Corp	Box 606 Kershaw, SC 29067	do	Do.
Limestone (crushed):			
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27612	Quarry and plant	Berkeley and Georgetown.
Southern Aggregates Co	Box 4510 Augusta, GA 30907	do	Berkeley.
Vulcan Materials Co	Box 7497 Birmingham, AL 35253	do	Cherokee.
Marl (crushed):			
Giant Portland & Masonry Cement Co.	Box 218 Harleyville, SC 29448	Pit	Dorchester.
Gifford-Hill & Co. Inc	Box 326 Harleyville, SC 29448	Pit	Do.
Santee Portland Cement Co	Box 698 Holly Hill, SC 29059	Pit	Orangeburg.
Vermiculite:			
Carolina Vermiculite Co. Inc	Box 98 Woodruff, SC 29388	Mines and plant	Spartanburg.
W. R. Grace & Co	Route 1 Enoree, SC 29335	do	Laurens.
Patterson Vermiculite Co	do	do	Do.

[1]Also kaolin.

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The Mineral Industry of South Dakota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Dakota Geological Survey for collecting information on all nonfuel minerals.

By Leon E. Esparza[1]

In 1987, the value of South Dakota's nonfuel mineral production reached a record $262.9 million, an increase of nearly 13% over the previous high established in 1986. The increase was due mainly to greater production of gold. Exploration for gold and other precious metals continued at a brisk pace. Twenty exploration permits were issued to 11 companies for projects in the Black Hills, in Custer, Lawrence, and Pennington Counties.

Table 1.—Nonfuel mineral production in South Dakota[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	4	W	4	W	4	W
Portland do.	655	W	635	W	519	W
Clays[2] do.	117	$309	119	$375	W	W
Feldspar short tons	13,721	W	W	W	W	W
Gem stones	NA	e70	NA	100	NA	$100
Gold (recoverable content of ores, etc.) troy ounces	356,103	113,119	W	W	W	W
Gypsum thousand short tons	34	269	31	268	W	W
Sand and gravel (construction) do.	e6,400	e16,000	9,713	19,853	e9,600	e19,100
Silver (recoverable content of ores, etc.) thousand troy ounces	63	388	W	W	W	W
Stone:						
Crushed thousand short tons	4,071	14,412	e3,600	e12,600	5,070	18,515
Dimension do.	51	18,336	e55	e18,399	51	18,209
Combined value of beryllium concentrates, clays (bentonite, 1985-86; common, 1987), lime, mica (scrap), and values indicated by symbol W	XX	44,800	XX	181,291	XX	206,968
Total	XX	207,703	XX	232,886	XX	262,892

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in South Dakota in 1986, by county[1]

County	Minerals produced in order of value
Aurora	Sand and gravel (construction).
Beadle	Do.
Bon Homme	Do.
Brookings	Do.
Brown	Do.
Brule	Do.
Buffalo	Do.
Butte	Clays, sand and gravel (construction).
Campbell	Sand and gravel (construction).
Charles Mix	Do.
Clark	Do.
Codington	Do.
Corson	Do.
Custer	Mica, feldspar, beryllium.
Davison	Sand and gravel (construction).
Day	Do.
Deuel	Do.
Douglas	Do.
Edmunds	Do.
Fall River	Do.
Faulk	Do.
Grant	Do.
Gregory	Do.
Haakon	Do.
Hamlin	Do.
Hand	Do.
Hanson	Do.
Harding	Do.
Hughes	Do.
Hutchinson	Do.
Hyde	Do.
Jackson	Do.
Jerauld	Do.
Jones	Do.
Kingsbury	Do.
Lake	Do.
Lawrence	Gold, sand and gravel (construction), silver.
Lincoln	Sand and gravel (construction).
Lyman	Do.
McCook	Do.
McPherson	Do.
Marshall	Do.
Meade	Do.
Mellette	Do.
Miner	Do.
Minnehaha	Do.
Moody	Do.
Pennington	Cement, lime, sand and gravel (construction), clays, gypsum.
Perkins	Sand and gravel (construction).
Potter	Do.
Roberts	Do.
Sanborn	Do.
Spink	Do.
Stanley	Do.
Sully	Do.
Todd	Do.
Tripp	Do.
Turner	Do.
Union	Do.
Walworth	Do.
Yankton	Do.
Ziebach	Do.
Undistributed[2]	Stone (dimension and crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Trends and Developments.—Objections to, and debate about, open pit gold mining and the use of cyanide heap-leaching methods continued to grow in 1987. In recent years, gold exploration for large low-grade deposits and open pit development had increased mainly because of improvements in cyanide heap-leach technology and a strong precious metals market.

Most of South Dakota's industrial mineral production was used by the construction industry. The U.S. Department of Commerce reported a modest construction decline in South Dakota in 1987. The number of private and public residential units authorized fell a little over 5% from 1986, and the value of nonresidential construction dropped about 4%. The value of State road contract awards paralleled this decline, falling about 10% for the same period.[2]

Mineral taxes in South Dakota are levied only on gold and silver production. Collections for fiscal year July 1, 1986, to June 30, 1987, totaled nearly $4.5 million, up about 18%.[3]

Mining employment totaled 2,626 in 1987, a slight increase over that of 1986.[4]

Legislation and Government Programs.—Laws enacted during the 1987 State legislative session had a major effect on mining in South Dakota. The legislative action ultimately resulted in a review and major redrafting of State mining regulations. Two laws in particular contributed to a need for the redraft. The first clarified the authority of local governments to enact zoning regulations relating to surface mining. The second law required the State Board of Minerals and Environment to make socioeconomic studies before issuing mine permits.

To comply with the new laws, the Governor ordered a 6-month hold, beginning in June, on processing mine permit applications and amendments. This action provided time for a Governor-appointed task force to draft new mining regulations. The task force consisted of members from academia, environmental advisory groups, the mining industry, and government. The new mining regulations unveiled in December included changes in permit procedures and rules for reclamation, heap leaching, and disposal of mill tailings.

In October, Lawrence County voters defeated by a greater than 3:1 margin a proposed moratorium on open pit gold mining. The moratorium would have delayed issuance of permits for new open pits until December 31, 1988, and also would have delayed major amendments to existing open pit mining permits. Part of the measure would have required the county commissioners to conduct a study of the cumulative effects of open pit mining. Local environmental groups continued efforts to include an open pit mining initiative on the 1988 statewide general election ballot. Although exact wording of the initiative was incomplete at yearend, the intent was to severely restrict growth of open pit projects in the Black Hills.

The proposed Sioux Nation Black Hills Act (U.S. Senate bill 705 and U.S. House bill 1506) was introduced in the 100th U.S. Congress. The stated purpose of the bill, which may affect the mining industry, was "to affirm the boundaries of the Great Sioux Reservation to convey federally held lands in the Black Hills to the Sioux Nation." The measure would return to the Sioux 1.3 million acres, which included nearly all Federal land in South Dakota, mostly west of longitude 103. All Federal lands in five counties and large parts of two counties would be included.

Although the proposed act indicated that individuals would not be deprived of valid existing rights of use or possession or any other contract right, there was disagreement whether these rights would be protected. Some observed that since the 1851 Treaty of Fort Laramie predates the Mining Law of 1872, existing mineral rights might not be valid.

The South Dakota School of Mines and Technology received nearly $72,000 from the State to study chlorination extraction for processing metallic ores. The study was to focus on gold-producing operations in the Black Hills and other Western States.

The U.S. Bureau of Mines distributed $205,000 to the State's Mining and Mineral Resources and Research Institute of the South Dakota School of Mines and Technology at Rapid City. The funds were provided as part of a program to assist the institute's efforts in training engineers and scientists in mineral-related disciplines.

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REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Beryllium.—Pacer Corp. produced beryl, feldspar, and mica from pegmatite deposits in Custer County. Production and value of beryllium decreased from 1986.

Gold and Silver.—The second largest gold mine in the country was in South Dakota. The State ranked third of 14 States in gold production. Gold production and value in 1987 increased nearly 7% and 30%, respectively. Lawrence County was the location for all the major gold operations in South Dakota. Homestake Mining Co. (HMC) was the State's largest gold producer. Gold production from HMC's Open Cut and Homestake Mines at Lead totaled about 326,000 troy ounces. Gold ore reserves at the Open Cut totaled 6,560,000 short tons at 0.126 ounce per ton. Ore reserves at the Homestake Mine were 19,032,000 tons at 0.213 ounce of gold per ton. Average production costs for the mines increased to $328 per ounce in 1987, up from $285 in 1986 due to declines in underground ore grades and prestripping costs at the Open Cut operation.[5] Homestake also produced silver as a coproduct of mine operations.

Wharf Resources (U.S.A.) Inc., a wholly owned subsidiary of Wharf Resources Ltd., a Canadian company, continued surface mining at its Annie Creek-Foley Ridge deposit in Lawrence County west of Lead in the Bald Mountain mining district. Total gold production in 1987 was about 46,000 ounces. Direct mining costs were $189 per ounce. Ore reserves totaled about 24 million short tons at an average grade of 0.041 ounce of gold per ton.[6] Wharf also recovered silver as a coproduct. In December 1987, Dickenson Mines Ltd. notified Wharf that it had acquired about 29% of Wharf's voting common stock.

Brohm Resources Inc. began construction in July of its Gilt Edge Mine. Gold production at the open pit and cyanide heap-leach operation was anticipated to be 42,000 ounces per year, gradually increasing to 135,000 ounces per year by 1991. The company said reserves were about 44 million tons of ore grading 0.043 ounce of gold per ton.[7]

Golden Reward Mining Co. was a joint venture composed of Moruya Gold Mines (1983) NL of Australia, Coin Lake Gold Mines Ltd. of Canada, and Ventures Trident of Colorado. The company's efforts to obtain a State mining permit were delayed because of the Governor's moratorium. It expected to begin construction by the summer of 1988 if a permit is awarded. Company-reported reserves for the proposed open pit and cyanide heap-leach operation were 12.5 million tons of ore with an average grade of 0.053 ounce of gold per ton for a contained 670,000 ounces of gold and 2.5 million ounces of silver.[8]

Goldstake Explorations (SD) Inc., in a joint venture with Strawberry Hill Mining Co. of Deadwood, announced plans to reclaim about 6 million tons of old gold-bearing tailings along an 18-mile stretch of Whitewood Creek in Meade County south of Whitewood.[9] The area had been on the Environmental Protection Agency Superfund list because of elevated arsenic concentrations in tailings. The mining and milling operations dated back to the 1870's.[10]

The operation would use gravity concentration and/or cyanide heap-leach technology and carbon-in-pulp methods to recover gold that the company reported averaged 0.06 ounce per ton.

St. Joe Gold Corp. filed a mine permit application with the State in late September for its Richmond Hill project. The open pit and cyanide heap-leach project had company-reported reserves of 3.9 million tons of ore, grading 0.053 ounce of gold and 0.23 ounce of silver per ton. The deposit occurs near the surface and reaches depths of about 245 feet. Annual production was anticipated at about 40,000 ounces of gold.[11]

INDUSTRIAL MINERALS

Cement.—Portland cement sales and attendant value decreased about 18% in 1987. During the same year, masonry cement production was essentially unchanged; however, value increased more than 13%. Changes in portland cement figures are attributed to a lengthy plant shutdown for repairs and decreased out-of-State sales. The only Government-owned cement plant in the Nation, and the only cement plant in South Dakota, was operated by the State near Rapid City. The business is administered by the seven-member South Dakota Cement Commission, which is appointed by the Governor. The facility can produce up to 1 million short tons of cement per year. Cement products are marketed in South Dakota, six adjacent States, and in Colorado. About 60% of the finished portland

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cement was sold to ready-mixed concrete companies, 14% to highway contractors, 9% to other contractors, and 17% to various other consumers.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates. Estimated production and value in 1987 was down slightly from the previous year's level.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Production and value of crushed stone in 1987 increased nearly 41% and 47%, respectively, establishing record highs. Limestone, which accounted for more than three-fourths of the crushed stone output, was produced by 8 companies from 11 quarries in 7 counties. Pennington County, in west-central South Dakota, was the source of most of the production. Quartzite and sandstone were produced by five companies at five quarries in Hanson, Mellette, Minnehaha, and Tripp Counties.

Table 3.—South Dakota: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	44	269
Filter stone	64	331
Coarse aggregate, graded: Concrete aggregate, coarse	428	2,061
Fine aggregate (-3/8 inch): Stone sand, bituminous mix or seal	110	521
Coarse and fine aggregates:		
Graded road base or subbase	261	843
Other construction[2]	205	878
Other miscellaneous[3]	974	1,930
Other unspecified[4]	2,984	11,682
Total	5,070	18,515

[1]Includes limestone, quartzite, and sandstone.
[2]Includes bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, stone sand (concrete), screenings (undesignated), and unpaved road surfacing.
[3]Includes cement manufacture, lime manufacture, and asphalt fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

Dimension.—Granite from Grant County was the only rock type used in dimension stone production. Sales of products for construction and monument use were reported by five companies operating nine quarries in the Milbank area. Production and value posted slight declines from the previous year's estimates.

Other Industrial Minerals.—Common clay and shale decreased in both production and value during 1987. The decreases resulted from lower cement production at the South Dakota Cement Commission plant. Feldspar production and value decreased about 27% and 20%, respectively. The value of gem stones collected during the year was estimated to have remained about the same as that of 1986. Crude gypsum production increased almost 10%, and value decreased almost 13%. Gypsum was used mostly in cement production. Output and value of lime fell almost 23% and 39%, respectively, and included both hydrated lime and quicklime. Scrap mica production and value decreased more than 17% and 28%, respectively.

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[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.
[2]Highway and Heavy Construction Magazine. June 1987, p. 36.
[3]Personal communication with South Dakota Department of Revenue.
[4]South Dakota Employment and Earnings Covered by Unemployment Insurance, 1987. South Dakota Dep. of Labor, p. 5.
[5]Homestake Mining Co. 1987 Annual Report to Stockholders.
[6]Wharf Resources Ltd. 1987 Annual Report to Stockholders.
[7]Mining Activity Digest, Engineering & Mining Journal International Directory. V. 14, No. 5, Oct. 30, 1987, p. 6.
[8]Engineering & Mining Journal. July 1987, p. 40.
[9]The Mining Record. Goldstake Proposing Joint Venture To Mine Gold Tailings. Sept. 9, 1987, p. 17.
[10]Lead Daily Call. Goldstake Site Toured. Sept. 4, 1987.
[11]St. Joe Gold Corp. Highlights of the 1987 Annual Meeting of Stockholders.

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Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Beryllium concentrate:			
Pacer Corp	Box 912 Custer, SD 57730	Mine and plant	Custer.
Cement:			
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	3 rotary kilns	Pennington.
Clays:			
American Colloid Co	5100 Suffield Ct. Skokie, IL 60076	Open pit and plant	Butte.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Open pit	Pennington.
Feldspar:			
Pacer Corp	Box 912 Custer, SD 57730	Open pits and dry-grinding plant.	Custer.
Gold:			
Homestake Mining Co	Box 875 Lead, SD 57754	Underground mine and open pit, cyanidation mill, refinery.	Lawrence.
Wharf Resources (U.S.A.) Inc	Box 897 Lead, SD 57754	Open pit and leach pads	Do.
Gypsum:			
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Open pit mine	Pennington.
Lime:			
Pete Lien & Sons Inc	Box 440 Rapid City, SD 57709	Rotary and vertical kilns, continuous-hydrator plant.	Do.
Mica:			
Pacer Corp	Box 912 Custer, SD 57730	Mine and dry-grinding plant	Custer.
Sand and gravel (construction, 1986):			
Birdsall Sand & Gravel Co	Box 767 Rapid City, SD 57709	Pits and plants	Fall River, Pennington, Sully.
Fischer Sand & Gravel Co	Box 1034 Dickinson, ND 58601	do	Charles Mix, Davison, Lawrence, Ziebach.
Mehlhoff Construction Co	Route 1, Box 25 Tripp, SD 57376	Pit and plant	Hutchinson.
Myrl & Roy's Paving Inc	1500 East 39th St. North Sioux Falls, SD 57101	Pits and plants	Minnehaha.
Sweetman Construction Inc	100 South Dakota Ave. Summit, SD 57266	do	Minnehaha and Roberts.
Silver:			
Homestake Mining Co	Box 875 Lead, SD 57754	See "Gold"	Lawrence.
Wharf Resources (U.S.A.) Inc	Box 897 Lead, SD 57754	do	Do.
Stone:			
Crushed:			
Limestone:			
Pete Lien & Sons Inc	Box 440 Rapid City, SD 57709	Quarries and plants	Custer and Pennington.
Northwestern Engineering Co. (Hills Materials Co.).	Box 2320 Rapid City, SD 57709	do	Pennington.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Quarry and plant	Do.
Sandstone-quartzite:			
Concrete Materials Co	Box 809 Sioux Falls, SD 57101	do	Minnehaha.
L. G. Everist Inc	Box 829 Sioux Falls, SD 57101	do	Do.
Spencer Quarries Inc	Box 25 Spencer, SD 57374	do	Hanson.
Dimension:			
Granite:			
Cold Spring Granite Co.	202 South 3d Ave. Cold Spring, MN 56320	Quarries and plant	Grant.
Dakota Granite Co	Box 1351 Milbank, SD 57252	do	Do.

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The Mineral Industry of Tennessee

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Tennessee Division of Geology for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] Ray Gilbert,[2] Gregory Upham[2]

In 1987, the value of extractive, nonfuel mineral production in Tennessee was reported to be $528 million. This was $52 million above the previous State record established in 1986. The new record was due primarily to substantial gains in the demand for construction raw materials—clays, sand and gravel, and stone—which historically have accounted for between 40% and 50% of the State's mineral value.

Despite the record-high year, it was a bleak period for the mining industry in the Ducktown Basin in southeastern Tennessee. The last pyrite-copper mine closed in July.

Table 1.—Nonfuel mineral production in Tennessee[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	1,244	$25,913	1,164	$25,228	1,261	$25,480
Gem stones	NA	e5	NA	W	NA	W
Phosphate rock thousand metric tons	1,233	27,000	r1,231	r21,191	W	W
Sand and gravel:						
Construction thousand short tons	e7,200	e22,000	7,360	24,592	e7,900	e28,900
Industrial do.	569	6,156	488	5,523	W	W
Stone:						
Crushed do.	e3 37,939	e3 155,760	e3 40,700	e3 175,600	51,406	227,243
Dimension do.	6	1,856	e6	e1,553	3	573
Zinc (recoverable content of ores, etc.) metric tons	104,471	92,971	102,118	85,550	115,699	106,926
Combined value of barite, cement, clays (fuller's earth), copper, lead (1985, 1987), lime, pyrites, silver, stone (crushed granite, 1985-86), and values indicated by symbol W	XX	141,109	XX	136,610	XX	138,670
Total	XX	r473,270	XX	r475,847	XX	527,812

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Tennessee in 1986, by county[1]

County	Minerals produced in order of value
Anderson	Clays.
Benton	Sand (industrial).
Campbell	Do.
Carroll	Sand (industrial), clays.
Cheatham	Sand and gravel.
Coffee	Do.
Cumberland	Do.
Decatur	Do.
Fayette	Do.
Fentress	Do.
Gibson	Clays.
Giles	Phosphate rock.
Greene	Sand and gravel.
Hamilton	Cement, clays.
Hardeman	Clays, sand and gravel.
Henry	Do.
Humphreys	Do.
Jefferson	Zinc.
Knox	Cement, zinc, clays, sand and gravel.
Loudon	Barite.
McMinn	Lime.
McNairy	Sand and gravel.
Madison	Do.
Marion	Do.
Marshall	Phosphate rock.
Maury	Do.
Obion	Sand and gravel.
Overton	Do.
Perry	Do.
Polk	Copper, zinc, silver, pyrites.
Putnam	Sand and gravel.
Roane	Do.
Sevier	Do.
Shelby	Do.
Smith	Zinc.
Sullivan	Clays.
Tipton	Sand and gravel.
Washington	Clays.
Wayne	Sand and gravel.
Weakley	Clays.
Williamson	Phosphate rock.
Undistributed[2]	Stone, cement, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—In May, the Governor signed into law bills that (1) provided conditions under which a mineral estate abandoned for 20 years can revert to the surface owner, and (2) required a Tennessee mining permit when disturbing 2 acres or less.

The Tennessee Geological Survey (TGS) officially operated as the Division of Geology of the Tennessee Department of Conservation and functioned as staff for the State Oil and Gas Board. During 1987, TGS's program of geological mapping at the 1:24,000 scale was slowed because staff time was preempted by work related to Tennessee's bid for the Department of Energy's massive Superconducting Super Collider project.

The Tennessee Valley Authority (TVA) fertilized and seeded 67 acres of eroded, abandoned manganese mines in Johnson and Carter Counties. The agency also planted 49,000 trees and shrubs on 79 previously mined acres in Johnson County that had been seeded and fertilized in 1986.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Barite.—Tennessee was one of six States reporting the production of barite, a barium sulfate used principally in the manufacture of chemicals and paint and in oil-well-drilling mud. Production was from the Sweetwater District in Loudon County, where barite occurred in the weathered residuum from limestones and dolomites in the Knox Group. One firm, A. J. Smith Co., continued as the sole producer; run-of-mine concentrates were shipped out of State for processing.

Cement.—The State's cement industry, with an annual clinker capacity of 1 million short tons, was located in the eastern part of Tennessee. Dixie Cement Co. Inc., Knoxville, operated a one-kiln, dry-process plant with an annual clinker capacity of 620,000 short tons, and Signal Mountain Cement Co., Chattanooga, operated a two-kiln, wet process plant with an annual clinker capacity of 450,000 short tons. Portland and masonry cement were produced by both companies. In 1987, portland cement production increased 1.9% and masonry cement production increased 10.7%. The increase in output was because of the strength of the construction industry in Tennessee and contiguous States.

Clays.—Tennessee ranked 10th among the 44 clay-producing States, and publishable clay sales accounted for approximately 5% of the State's total mineral value. The clay industry consisted of 9 companies operating 33 mines in 5 eastern and 4 western counties. Production, in descending order of value, included ball clay, common clay and shale, and fuller's earth.

The State was the Nation's leader in ball clay output. Ball clay was produced in the Carroll, Gibson, Henry, and Weakley contiguous-county area in northwestern Tennessee. Production totaled 646,000 short tons valued at $25 million, an increase of 72,000 short tons over that reported in 1986. The increase in production was due to the strong housing market; primary sales were to the sanitaryware and tile industries.

Common clay and/or shale were produced in Anderson-Knox, Sullivan-Washington, and Hamilton Counties in the eastern part of Tennessee, and in Henry County in the western part. Production increased 27,000 short tons over that reported in 1986 as a result of the strong demand for brick, cement, clay pipe, and other structural clay products.

A montmorillonite fuller's earth was produced by Lowe's Inc. from a surface mine in Henry County. After processing, the clay was marketed as an industrial and pet waste absorbent and as an insecticide and fungicide carrier. Output increased 3% over the 1986 production.

Lime.—Tenn-Luttrell Lime Co., a subsidiary of Penn-Virginia Corp., and Bowater Southern Paper Corp. were the State's two lime producers in 1987. Tenn-Luttrell operated a surface mine, an 800-short-ton-per-day lime plant housing a 170-foot rotary, coal-fired kiln, and a grinding plant at Luttrell northeast of Knoxville. Bowater produced lime to be used during the papermaking process. The principal markets for the State's lime output were the paper, steel and water purification industries. Production was 4% lower than in 1986.

Phosphate Rock.—Tennessee ranked third among the six phosphate-rock-producing States. Two companies mined phosphate-bearing residual clays weathered from Ordovician limestones in Giles, Hickman, Maury, and Williamson Counties. A plant in Columbia and one at Mount Pleasant converted the rock to elemental phosphorous, which was used to manufacture a variety of individual chemicals. Production plummeted almost 50% after Monsanto Co.'s operation closed in 1986.

During the year the TVA sold the mineral rights to about 2,400 acres in Giles County. The agency had acquired the acreage in the 1930's and 1940's when TVA officials considered mining the ore for its elemental phosphorus manufacturing complex at Muscle Shoals, AL. The purchaser, Occidental Chemical Corp., began mining the Giles County purchase in midyear.

Pyrites.—Tennessee Chemical Co. mined and processed pyrite in the Ducktown Basin in Polk County in the southeast part of the State. The chemical complex at Copperhill produced sulfuric acid and liquid sulfur dioxide. Byproducts included blister copper, iron sinter, and zinc concentrates. The company closed the remaining mines in July. Company officials stated that raw materials were less costly to purchase than to mine.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel sales and

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production accounted for an estimated 5% of the State's total mineral value. In 1986, the latest year canvassed, 43 companies operated 54 pits. Six of the top 10 producing counties were in the western part of the State, and their output accounted for 65% of Tennessee's total.

Industrial.—In 1986, three companies operated four pits in Benton, Campbell, Carroll, and Henry Counties. The 1987 production exceeded slightly that reported in 1986. In 1986, primary sales, in descending tonnages, were to the container, mold and core, blasting, filtration, and traction markets.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Sales of crushed stone accounted for 43% of the State's mineral value in 1987, and Tennessee ranked 9th among the 49 crushed stone producing States. Production exceeded that estimated for 1986 by 10 million short tons. The increase in production and sales was due to the strong demand for construction mineral commodities.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three Tennessee districts depicted in figure 1.

Table 3.—Tennessee: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	434	1,792
Filter stone	380	1,785
Coarse aggregate, graded:		
Concrete aggregate, coarse	4,413	19,260
Bituminous aggregate, coarse	7,560	32,186
Bituminous surface-treatment aggregate	652	3,172
Fine aggregate (-3/8 inch):		
Stone sand, bituminous mix or seal	332	1,296
Screening, undesignated	2,619	11,763
Coarse and fine aggregates:		
Graded road base or subbase	7,781	31,541
Unpaved road surfacing	1,061	4,578
Crusher run or fill or waste	6,776	26,360
Other construction[2]	1,718	8,222
Agricultural:		
Agricultural limestone	1,153	4,016
Poultry grit and mineral food	86	753
Special:		
Asphalt fillers or extenders	179	498
Other miscellaneous[3]	1,825	10,273
Other unspecified[4]	14,437	69,819
Total[5]	51,406	227,264

[1]Includes limestone, dolomite, granite, marble, and miscellaneous stone.
[2]Includes macadam, railroad ballast, fine aggregate, stone sand (concrete), combined coarse and fine aggregates, coarse aggregate (large), and terrazzo and exposed aggregate.
[3]Includes cement and lime manufacture, other agricultural uses, sulfur oxide removal, mine dusting and acid water treatment, whiting or whiting substitute, other fillers or extenders, glass manufacture, and waste materials.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown becaused of independent rounding.

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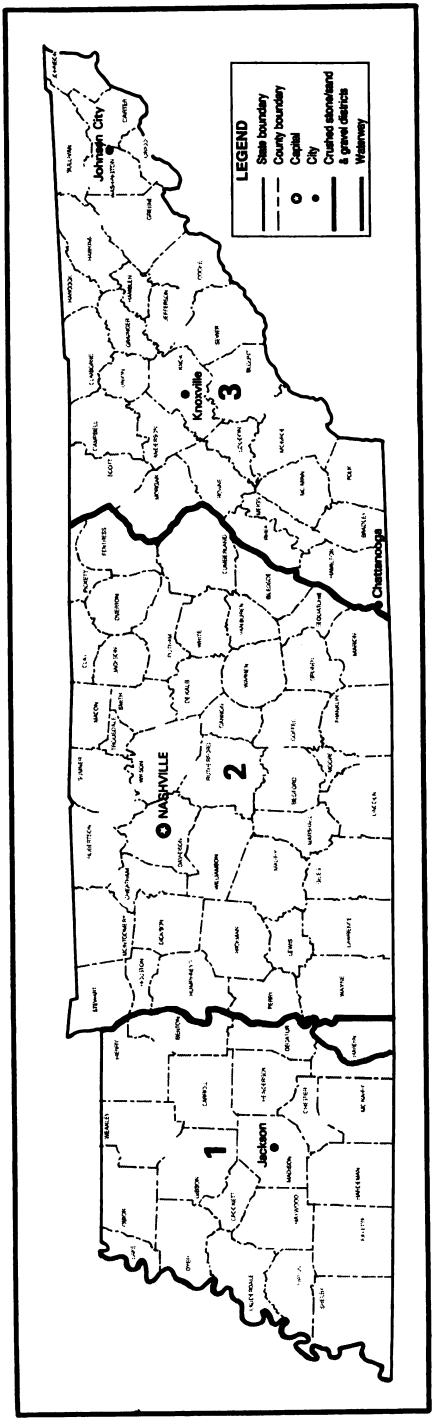

Figure 1.—Aggregate-producing districts in Tennessee.

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Table 4.—Tennessee: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	W	W	463	1,730	W	W
Coarse aggregate, graded[2]	W	W	5,719	23,477	W	W
Fine aggregate (-3/8 inch)[3]	W	W	1,238	4,735	W	W
Coarse and fine aggregates[4]	W	W	8,497	31,377	W	W
Other construction	--	--	574	2,231	W	W
Agricultural[5]	W	W	231	1,338	W	W
Chemical and metallurgical[6]	--	--	(7)	(7)	W	W
Special[8]	--	--	(7)	(7)	W	W
Other unspecified[9]	--	--	(7)	(7)	W	W
Total	W	W	25,783	113,409	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal), fine aggregate (screening, undesignated).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill or waste.
[5]Includes agricultural limestone, poultry grit and mineral food, and agricultural uses.
[6]Includes cement manufacture, lime manufacture, flux stone, glass manufacture, and sulfur oxide removal.
[7]Withheld to avoid disclosing company proprietary data; included in "Total."
[8]Includes mine rock dusting, asphalt filler, whiting or whiting substitute, other fillers or extenders, and waste material.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.

Dimension.—Tennessee's dimension stone industry, six companies, operated six quarries in the eastern part of the State. Both sandstone from the Crab Orchard area on the Cumberland Plateau and marble from eastern Tennessee were produced.

Other Industrial Minerals.—Several industrial minerals were shipped into the State for manufacturing into a higher value product. The value of these minerals are not noted on table 1, but in most cases are included in the value data for the State in which they were mined. Two companies operated three plants in Carter, Maury, and Montgomery Counties to produce electric-furnace electrodes and high-modulus graphite fibers. Both products were manufactured from petroleum coke and coal tar pitch. One company produced organo-lithium compounds at a plant in New Johnsonville. Lithium carbonate used in the organo-lithium manufacturing process came from company operations in Nevada. A Nashville firm expanded perlite obtained from mines in New Mexico. Principal sales were to the horticultural, construction, and filter industries. Fused silica was manufactured at a Greenville plant. Output was used in the manufacture of silica nozzles, shrouds, and other specialty products. The same plant produced three refractory grades of fused magnesia. Vermiculite obtained from South Carolina was exfoliated at a Nashville plant. Principal sales were to the insulation market.

METALS

Zinc and copper were the only metals mined instate. Copper concentrates were obtained from pyrite beneficiation at Copperhill in the southeastern part of the State, and zinc was produced from sphalerite mined in eastern and central Tennessee.

Copper.—Commercial copper mining in southeastern Tennessee began in 1843. On July 31, 1987, Tennessee Chemical Co. closed its last pyrite-copper mine. The closure was due to economics; the company could purchase raw materials for chemical manufacturing cheaper than by mining. The chemical company, the largest employer and taxpayer in the region, announced its closing in 1985 so that workers and region officials could have advance notice. Over 800 workers were terminated or retired.

Zinc.—Tennessee accounted for 54% of the Nation's zinc production. There was a 13,600-ton increase over the 1986 figure, due to a slight rise in the price of zinc over the depressed prices of the past few years.

Three companies operated seven mines in eastern (five mines) and central (two mines) Tennessee. In the eastern part of the State,

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ASARCO Incorporated operated four mines and two mills; USX Corp. operated one mine and mill. In central Tennessee, Jersey Minière Zinc Co. operated two mines and a mill. An electrolytic zinc refinery was in operation in Clarksville, northwest of Nashville.

At yearend, industry officials were concerned over a proposed free trade agreement between the United States and Canada, which was scheduled to be debated in Congress in 1988. The Canadian government had subsidized the rehabilitation of Canadian zinc mines, and U.S. zinc officials had stated that the domestic zinc industry could not compete against subsidized imports.

Other Metals.—Aluminum Co. of America operated a 220,000-ton-per-year plant at Alcoa. Plant feed was obtained from foreign sources. The company dedicated its new, $150 million, continuous cold mill in October. By the end of 1987, the State had only two ferroalloy producers. Applied Industrial Minerals Corp. closed its ferrosilicon plant at Kimball because of low-priced imports, and only Stauffer Chemical Co. and Occidental Chemical Petroleum Corp., ferrophosphorus producers, were still operating. Jersey Minière recovered cadmium and germanium residues from zinc ores at its Clarksville refinery. The residues were shipped to Belgium for processing. Florida Steel Corp., Jackson; Tennessee Forging Steel Corp., Harriman; and Knoxville Iron Co. Knoxville, Tennessee's steel industry. The three producers had an annual capacity of 580,000 short tons per year. During the year, Florida Steel purchased Knoxville Steel. In June, Foote Industries sold its electrolytic manganese dioxide plant at New Johnsonville to Chemetals, a Maryland-based company, the plant produced materials used in the manufacture of alkaline batteries. Monazite mined in Australia was processed at a W. R. Grace & Co. plant in Chattanooga, the company produced rare-earth catalysts and compounds. E. I. du Pont de Nemours & Co. Inc. operated the world's largest titanium dioxide plant, 228,000-ton-per-year capacity, near New Johnsonville. The company produced titanium dioxide pigments from ilmenite mined at Starke, FL, and Eneabba, Western Australia.

[1]State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.
[2]Geologists, Tennessee Division of Geology, Nashville, TN.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum smelters:			
Aluminum Co. of America	Box 158 Alcoa, TN 37701	Plant	Blount.
Consolidated Aluminum Corp	1102 Richmond St. Jackson, TN 38301	do	Humphreys.
Barite:			
A. J. Smith Co	Route 3 Sweetwater, TN 37874	Open pit mine	Loudon.
Cement:			
Dixie Cement Co. Inc.,[1 2] a subsidiary of Moore McCormack Cement Inc.	Box 14009 Knoxville, TN 37914	Plant	Knox.
Signal Mountain Cement Co	1201 Suck Creek Rd. Chattanooga, TN 37405	do	Hamilton.
Clays:			
Cyprus Industrial Minerals Co	Box 111 Gleason, TN 38229	Pits and plants	Carroll and Weakley.
General Shale Products Corp	Box 3547 CRS Johnson City, TN 37601	do	Anderson, Hamilton, Knox, Sullivan, Washington.
Kentucky-Tennessee Clay Co	Box 449 Mayfield, KY 42066	do	Carroll, Gibson, Henry, Weakley.
Lowe's Inc	Box 819 Paris, TN 38242	do	Henry.
Old Hickory Clay Co	Box 188 Gleason, TN 38229	do	Henry and Weakley.
H. C. Spinks Clay Co. Inc	Box 820 Paris, TN 38229	do	Carroll, Henry, Weakley.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Copper:			
Tennessee Chemical Co.[3] (closed July 31, 1987).	Copperhill, TN 37317	Underground mines, surface mine, plant.	Polk.
Graphite (synthetic):			
Akzo-Enka American	Box 1301 Rockwood, TN 37643	Plant	Roane.
Union Carbide Corp	Box 513 Columbia, TN 38401	do	Maury.
Lime:			
Bowater Southern Paper Corp	U.S. Highway 11 Calhoun, TN 37309-0188	do	McMinn.
Tenn-Luttrell Lime Co	Box 69 Luttrell, TN 37779	do	Union.
Perlite (expanded):			
Chemrock Corp	Osage St. Nashville, TN 37208	do	Davidson.
Phosphate rock:			
Occidental Chemical Corp.[4]	Box 591 Columbia, TN 38401	do	Do.
Stauffer Chemical Co.[4]	Box 89 Mount Pleasant, TN 38474	do	Do.
Sand and gravel:			
Dixie Sand & Gravel Co	515 River St. Chattanooga, TN 37402	Pits	Hamilton.
Memphis Stone & Gravel Co	Box 1683 Memphis, TN 38101	do	Benton, Dyer, Shelby.
Rogers Group Inc.[2]	Box 25250 Nashville, TN 37202	do	Tipton.
Standard Construction Co. Inc	Box 38289 Germantown, TN 38138	Pit	Shelby.
Stone:			
Limestone:			
American Limestone Co	180 Maiden Lane New York, NY 10038	Quarries	Jefferson, Knox, Sullivan.
Hoover Inc	Box 17346 Nashville, TN 37217	do	Bedford, Hamilton, Rutherford, Warren.
Vulcan Materials Co	Box 7497 Birmingham, AL 35253	do	Do.
Marble:			
John J. Craig Co	Box 9300 Knoxville, TN 37920	Quarry	Blount.
Imperial Black Marble Corp	8013 Chesterfield Dr. Knoxville, TN 37919	do	Grainger.
Sandstone:			
Ross L. Brown Cut Stone Co. Inc.	Box 398 Crab Orchard, TN 37723	do	Cumberland.
Crab Orchard Stone Co. Inc	Drawer J Crossville, TN 38555	do	Do.
Crossville Limestone Co. Inc	Box 485 Crossville, TN 38555	do	Do.
Mountain Stone Co	Box 246 Jamestown, TN 38556	do	Fentress.
Vermiculite (exfoliated):			
W. R. Grace & Co	4061 Powell Ave. Nashville, TN 37204	Plant	Davidson.
Zinc:			
ASARCO Incorporated[2]	Mascot, TN 37806	Underground mines and plant.	Jefferson and Knox.
Inspiration Resources Corp	Box 32 Jefferson City, TN 37760	Underground mine and plant.	Jefferson.
Jersey Minière Zinc Co	Elmwood, TN 38560	Underground mines, plant, smelter.	Smith.
USX Corp.[3]	Jefferson City, TN 37760	Underground mine	Jefferson.

[1]Also clays.
[2]Also stone.
[3]Also pyrites, silver, and zinc.
[4]Also ferroalloys.

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The Mineral Industry of Texas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Economic Geology, The University of Texas at Austin, for collecting information on all nonfuel minerals.

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Total value of nonfuel minerals produced in Texas in 1987 was $1.4 billion, a 16.4% decrease from 1986. The State fell from second rank that it held during 1983-86 to fourth in the Nation in 1987. Much of the decline in nonfuel mineral production was due to the precipitous decline of the oil industry, which had supported industries producing steel tubular goods, drilling muds, and oil-well cement. The concomitant decline of the real estate industry influenced the construction business, a large consumer of cement.

Table 1.—Nonfuel mineral production in Texas[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	263	$22,114	209	$15,790	172	$11,283
Portland do.	10,242	532,494	8,883	412,697	7,318	319,996
Clays do.	4,107	28,059	[2]2,515	[2]11,724	3,475	25,959
Gem stones	NA	[e]175	NA	297	NA	345
Gypsum thousand short tons	1,981	17,299	2,131	14,982	1,874	14,254
Lime do.	1,192	65,927	1,173	62,670	1,140	59,027
Salt do.	8,390	84,249	8,520	62,996	7,810	60,857
Sand and gravel:						
Construction do.	[e]57,800	[e]198,000	59,562	209,855	[e]48,200	[e]178,600
Industrial do.	1,968	29,095	1,302	18,274	1,509	22,843
Stone:						
Crushed do.	85,764	306,821	[e]84,200	[e]301,500	84,347	276,477
Dimension do.	36	11,209	[e]49	[e]15,407	75	10,030
Sulfur (Frasch) thousand metric tons	2,979	W	2,506	W	2,152	W
Talc thousand short tons	261	5,245	283	6,456	255	4,380
Combined value of asphalt (native, 1985-86), clays (ball clay, fuller's earth, and kaolin, 1986), fluorspar (1985-86), helium (crude and Grade-A), iron ore (usable), magnesium chloride (1985), magnesium compounds, magnesium metal (1986-87), mica (scrap, 1985), sodium sulfate (natural), and values indicated by symbol W	XX	435,936	XX	579,340	XX	446,679
Total	XX	1,736,623	XX	1,711,988	XX	1,430,730

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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The value of Texas nonfuel minerals output accounted for 5.4% of the national total. Mined in the State in 1987 were 19 nonfuel minerals: 17 industrial minerals and 2 metals (iron, in the form of low-grade limonite-siderite, and magnesium metal).

Table 2.—Nonfuel minerals produced in Texas in 1986, by county[1]

County	Minerals produced in order of value
Atascosa	Sand (industrial).
Bastrop	Sand and gravel, clays.
Bell	Sand and gravel.
Bexar	Cement, sand and gravel, lime, clays.
Borden	Sand and gravel.
Bowie	Do.
Brazoria	Salt, magnesium chloride, sand and gravel, magnesium compounds.
Brazos	Sand and gravel.
Brewster	Fluorspar.
Burnet	Sand and gravel.
Cass	Iron ore.
Chambers	Salt, sand and gravel.
Cherokee	Clays, iron ore.
Coke	Sand and gravel.
Coleman	Clays.
Colorado	Sand and gravel.
Comal	Cement.
Comanche	Clays.
Cooke	Sand and gravel.
Coryell	Do.
Culberson	Sulfur, talc, sand and gravel.
Dallas	Sand and gravel, cement, clays.
Denton	Sand and gravel, clays.
De Witt	Sand and gravel.
Duval	Salt.
Eastland	Clays, sand and gravel.
Ector	Cement, salt, clays.
Ellis	Cement, sand and gravel, clays.
El Paso	Sand and gravel, cement.
Fannin	Sand and gravel.
Fayette	Clays, sand and gravel.
Fort Bend	Salt, sand and gravel, clays.
Gaines	Sodium sulfate.
Galveston	Sand and gravel.
Garza	Do.
Gillespie	Gypsum, sand and gravel.
Gonzales	Clays.
Guadalupe	Clays, sand and gravel.
Hansford	Helium.
Hardeman	Gypsum.
Hardin	Sand and gravel.
Harris	Cement, salt, sand and gravel, clays.
Harrison	Clays.
Hays	Cement, sand and gravel.
Henderson	Sand and gravel, clays.
Hidalgo	Sand and gravel.
Hood	Do.
Houston	Do.
Hudspeth	Talc.
Hutchinson	Sand and gravel.
Jefferson	Salt, sand and gravel.
Johnson	Sand and gravel.
Jones	De.
Lamar	Sand and gravel.
Lampasas	Do.
Liberty	Do.
Limestone	Clays, sand and gravel.
Live Oak	Sand and gravel.
Lubbock	Do.
McCulloch	Do.
McLennan	Cement, sand and gravel, clays.
Madison	Sand and gravel.
Matagorda	Salt.
Maverick	Sand and gravel.
Medina	Do.
Midland	Do.
Montgomery	Do.
Moore	Helium.
Motley	Sand and gravel.

See footnotes at end of table.

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Table 2.—Nonfuel minerals produced in Texas in 1986, by county[1] —Continued

County	Minerals produced in order of value
Nacogdoches	Clays.
Navarro	Sand and gravel.
Newton	Do.
Nolan	Cement, gypsum, sand and gravel.
Nueces	Sand and gravel, cement.
Oldham	Sand and gravel.
Orange	Cement, sand and gravel.
Palo Pinto	Clays, sand and gravel.
Parker	Sand and gravel, clays.
Pecos	Sand and gravel.
Potter	Cement, sand and gravel.
Reeves	Sand and gravel.
Runnels	Do.
Smith	Sand and gravel, clays.
Somervell	Sand and gravel.
Starr	Do.
Stonewall	Gypsum.
Tarrant	Cement, sand and gravel.
Taylor	Sand and gravel.
Terry	Sodium sulfate.
Throckmorton	Sand and gravel.
Travis	Do.
Upshure	Do.
Uvalde	Do.
Val Verde	Do.
Van Zandt	Salt, clays.
Victoria	Sand and gravel.
Walker	Clays.
Waller	Sand and gravel.
Ward	Do.
Webb	Do.
Wharton	Sulfur.
Wise	Sand and gravel, clays.
Wood	Do.
Young	Sand and gravel.
Undistributed[2]	Stone, gem stones, asphalt.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—The Texas Bureau of Economic Geology, with funding provided by the Texas Mining and Mineral Resources Research Institute, which is funded in part by the U.S. Bureau of Mines, studied unusual rhyolite intrusions that are enriched in beryllium, fluorine, thorium, rare earth elements, and other rare metals.[3]

Rhyolite intrusions near Sierra Blanca in Trans-Pecos Texas were the sources of beryllium and fluorine in deposits along rhyolite and Cretaceous limestone contacts.[4]

In a related study, the Texas Bureau of Economic Geology mapped the geology of the Christmas Mountains area of southern Trans-Pecos, which is also considered favorable for rare metal deposits. Lithium-rich micas in Hudspeth County and potential sulfur resources on State-owned lands also were studied.

Employment.—Texas economic outlook improved at yearend 1987. Unemployment fell to 7.5% in December, the lowest rate in nearly 2 years.

Exploration Activities.—At the Sierra Blanca prospect in Hudspeth County, Cyprus Minerals Co. and Cabot Corp. in a joint venture were evaluating a beryllium ore body containing bertrandite, benoite, and phenacite. The ore body contains the equivalent of more than 25 million pounds of beryllium oxide at an average grade of 2.5%.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—The continued low level of activity in the construction and oil-drilling industries and a continuing increase in imports of both clinker and finished cement depressed the cement industry for the third year. Portland cement production was down 17.6% from that of 1986 and 28.6% from that of 1985. Total value of portland cement output fell 42.6% between 1984 and 1987; nevertheless, Texas ranked 2nd of 40 portland cement producing States. The price of oil-well-type portland cement sold in 1987 averaged $49.14 per ton, down 10% from the 1986 average and 21% from that of 1985. The average price of all types of portland cement (including that for the oil industry) was $43.73. Masonry cement output and value declined about 17% and 29%, respectively.

Ten firms operated 14 cement plants, with 12 wet-process and 12 dry-process kilns.

Raw materials consumed were 7.0 million short tons of limestone, 1.0 million tons of marl, 0.9 million tons of chalk, 0.9 million tons of cement rock, 0.47 million tons of clay, 0.35 million tons of shale, 0.27 million tons of sand, 0.27 million tons of gypsum, and smaller amounts of fly ash, iron ore, mill scale, and various resins and chemicals. In addition, 0.63 million tons of clinker were used, the majority (52%) of which was of foreign origin, principally from Mexico.

In descending order, finished portland cement was sold to ready-mixed concrete companies (67% of shipments), concrete product manufacturers, other contractors, highway contractors, miscellaneous customers, building material dealers, and government agencies. More than 80% of finished cement was sent directly from the plant to the ultimate consumer, mostly by bulk truck shipment. Less than 20% of total shipments was from plant to terminal and these were shipped primarily in bulk, utilizing both rail (57% of shipments) and truck.

The investment by foreign interests in Texas cement plants continued in 1987, with Presa Spa acquiring Kaiser Cement Corp.'s Longhorn plant in San Antonio. Presa also held an interest in another San Antonio plant, Alamo 1604 (operated by Alamo Cement Co.), and reported that Longhorn eventually will be used as a distribution center for Alamo cement.

BoxCrow Cement Co.'s new 1-million-ton-per-year plant at Midlothian (Ellis County) came on-line in 1987 but, like most Texas plants, its production remained substantially below capacity.

The Texas Mining and Mineral Resources Research Institute provided some funding for a Texas Bureau of Economic Geology study of current and potential resources for the State's cement portland industry.

Clays.—Output and value of most clays rose significantly from 1986. Texas firms produced ball clay, bentonite, common clay and shale, fire clay, fuller's earth, and kaolin; only bentonite and fire clay outputs were reported to be less than in 1986. Bentonite is used in oil-well-drilling muds and fire clay is used to make refractory linings for kilns; both products were used by depressed industries.

Clay mining involved 27 companies, which operated 65 pits in 27 of 254 counties in Texas: 51 pits produced common clay and shale; 1 pit each, fuller's earth and kaolin; 2 pits, fire clay; 4 pits, ball clay; and 9 pits, swelling or nonswelling bentonite.

In decreasing order, by volume, common clay and shale was mined from Navarro, Guadalupe, Eastland, Cherokee, and 19 other counties; ball clay from Gonzales and Harrison Counties; bentonite from Gonzales and Fayette Counties; fire clay from Wood County; fuller's earth from Fayette County; and kaolin from Limestone County.

Values of Texas clays ranged widely but averaged $7.47 per ton, down nearly 10% from that of 1986.

Southern Clay Products Inc., a major calcium bentonite producer, planned a major expansion of its "organoclay" production facility at Gonzales. Southern Clay was a subsidiary of ECC America Inc., which was, in turn, a subsidiary of ECCI of the United Kingdom (formerly English China Clays PLC).

Payne Brick Co., of Elgin, Bastrop County, was sold to U.S. Brick Inc. U.S. Brick now owns five Texas operations, including two in San Antonio, Bexar County, and two in Mineral Wells, Palo Pinto County.

Lime.—The combined quantity of lime sold for use in acid-water neutralization, agriculture, aluminum and bauxite processing, glassmaking, mason's lime, open-hearth steelmaking, ore concentration,

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sewage treatment, sugar refining, tanning, and several other uses increased more than 450%, but the quantity of lime sold for water purification fell 58%.

The Clifton plant of Chemical Lime Co. Inc., Fort Worth, was the Nation's 11th largest producer of lime; the plant in Bosque County produced both quicklime and hydrated lime. In the restructuring of USG Corp., A. P. Green Refractories Co. was set up as a separate subsidiary and USG transferred its lime business to A. P. Green, including the Comal County lime plant formerly operated by United States Gypsum Co. Five other lime plants were operated in Bexar, Deaf Smith, Hill, Johnson, and Travis Counties; all reported both quicklime and hydrated lime production.

Table 3.—Texas: Lime sold or used by producers, by use

Use	1986		1987	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Paper and pulp	44,151	2,241	W	W
Road stabilization	341,371	18,476	W	W
Soil stabilization	334,384	18,820	W	W
Steel, electric	115,939	5,587	W	W
Water purification	142,982	7,290	59,999	3,127
Other[1]	194,594	10,256	1,079,731	55,900
Total	1,173,421	62,670	1,139,730	59,027

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes acid water neutralization, agriculture, aluminum and bauxite, finishing lime (1986), food and byproducts (1986), glass, mason's lime, oil well drilling (1986), open-hearth steel, ore concentrate, other chemical and industrial uses, other stabilization, petroleum refining (1986), sewage treatment, sugar refining, tanning, and data indicated by symbol W.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Although output and total value fluctuated during the 1984-87 period, price per short ton of construction sand and gravel continued to increase and was estimated to be $0.36 above the national average at the end of the period. Texas ranked second among the 50 States producing construction sand and gravel.

Industrial.—Nine firms operated 13 industrial sand pits. More than one third of the production came from McCulloch County. Unit value, by use, of industrial sand ranged from $9.43 per short ton for chemicals to $26.50 for porcelains. The average unit value for all uses was $15.14. More than 90% of industrial sand output was transported by truck; the remainder was moved by rail.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Texas, usually the Nation's leader in crushed stone output, fell behind Pennsylvania in 1987. Still, Texas output was insignificantly less in 1987 than that reported in 1985. The 1987 output represented 7% of the national total. Most production came from 185 limestone quarries (or limestone combined with other rock types). Dolomite, marble, marl, sandstone, traprock, and other crushed stone also were extracted. Crushed stone production value declined about 8% from that estimated for 1986 and nearly 10% from the production value reported in 1985.

The five largest crushed stone producers in the State were Redland Worth Corp., Texas Crushed Stone Co., Parker Bros. & Co., Texas Industries Inc., and Gifford-Hill Co. Inc. Operating 27 quarries, these 5 companies together produced 40% of the quantity and 37% of the value of the State's crushed stone in 1987. Each company's output was more than 5 million short tons. Sixteen other companies, operating 48 quarries, each produced 1 million or more tons for a combined (21 companies) total of 72% of the crushed stone tonnage and 67% of its value.

The combined output of crushed limestone and crushed dolomite was 82.6 million tons valued at $262.2 million. Unit values averaged $3.43 per ton.

Texas producers listed 32 specific uses of crushed stone; in order of decreasing volume, crushed stone was used for graded road base, cement manufacture, concrete aggregates, bituminous aggregates, and 28

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other uses.

Of the total crushed stone shipped, 74% was transported by truck and 21% by railroad.

Several trends in the aggregates business affected rock producers in Texas. One was the increasing use of large, mobile crushers, used for some time in Europe but only recently installed in some U.S. quarries. A 5,000-ton-per-hour walking crusher was installed by Redland Worth at its San Antonio quarry in early 1987 and a 1,200-ton-per-hour pneumatic-tire mobile crusher was placed at BoxCrow Cement's quarry in Midlothian. Portable rock crushers were also used in smaller operations, particularly in the Texas Panhandle and at some sites along the gulf coast.

Other trends were the increased movement of aggregate or crushed stone by rail and the quarrying of construction materials in Mexico for shipment to gulf coast markets. An example of the latter was the new joint venture between Vulcan Materials Co. and Mexico's Grupo ICA. Initial markets were to be Beaumont, Freeport, Galveston, Houston, and Port Arthur, as well as ports in Florida and Louisiana.

Vulcan Materials acquired, for about $89 million, the stock of White's Mines Inc. and Statewide Transport Inc. and a substantial portion of R. L. White Co. This included White's rock asphalt quarry at Uvalde, basalt quarry at Knippa, and three limestone quarries at Brownwood, Abilene, and Weatherford. Total crushed stone reserves at these locations were approximately 250 million short tons. Franklin Industries Inc., Nashville, TN, added another Texas limestone quarry with its buyout of Tonk Products' McLennan County quarry. Franklin has operated a quarry at nearby Nolanville for several years. General Portland Inc., a division of LaFarge Corp., bought East Texas Stone Co.'s Blue Mountain sandstone quarry in Freestone County.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 5 presents end-use data for crushed stone produced in the nine Texas districts depicted in figure 1.

Table 4.—Texas: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	530	3,003
Filter stone	212	885
Coarse aggregate, graded:		
Concrete aggregate, coarse	9,897	38,975
Bituminous aggregate, coarse	5,578	25,696
Bituminous surface-treatment aggregate	1,073	5,815
Railroad ballast	333	1,371
Fine aggregate (-3/8 inch):		
Stone sand, concrete	1,685	6,470
Stone sand, bituminous mix or seal	1,305	5,606
Screening, undesignated	957	2,332
Other fine aggregate	3	25
Coarse and fine aggregates:		
Graded road base or subbase	26,101	60,009
Unpaved road surfacing	1,779	4,452
Terrazzo and exposed aggregate	15	125
Crusher run or fill or waste	1,211	1,911
Other construction[2]	514	1,802
Agricultural:		
Agricultural limestone	190	412
Poultry grit and mineral food	62	462
Chemical and metallurgical:		
Cement manufacture	9,964	21,828
Lime manufacture	724	2,995
Sulfur oxide removal	517	2,190
Special:		
Other fillers and extenders	329	7,052
Other miscellaneous[3]	1,403	6,794
Other unspecified[4]	19,964	76,268
Total[5]	84,347	276,477

[1]Includes limestone, sandstone, dolomite, marl, traprock, marble, shell, and miscellaneous stone.
[2]Includes coarse aggregate (graded) and dam construction.
[3]Includes disinfectant and animal sanitation, flux stone, chemical stone for alkali works, mine dusting and acid water treatment, asphalt fillers or extenders, whiting or whiting substitute, roofing granules, and paper manufacture.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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Table 5.—Texas: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4		District 5	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	--	--	3	10	[2]	[2]	--	--	203	1,306
Coarse aggregate, graded[4]	[5]	[5]	[2]	[2]	203	1,328	[2]	[2]	6,847	27,818
Fine aggregate (-3/8 inch)[6]	[5]	[5]	[2]	[2]	78	171	[2]	[2]	1,042	2,420
Coarse and fine aggregates[7]	1,170	4,427	234	800	893	2,256	[3]	[3]	5,659	15,711
Other construction	--	--	93	430	10	52	1,951	6,701	148	183
Agricultural[8]	--	--	--	--	--	--	--	--	[5]	[5]
Chemical and metallurgical[9]	[5]	[5]	--	--	[5]	[5]	[3]	[3]	4,596	10,608
Special[10]	[5]	[5]	--	--	[5]	[5]	--	--	499	5,085
Other miscellaneous	557	3,288	--	--	946	2,122	--	--	86	513
Other unspecified[11]	1,285	4,861	10	36	1,233	6,657	1,305	5,205	10,018	38,280
Total[12]	3,012	12,576	340	1,275	3,363	12,586	3,256	11,906	29,098	101,923

Use	District 6		District 7		District 8		District 9	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	[3]	W	516	2,391	10	W	--	--
Coarse aggregate, graded[4]	--	--	9,353	39,856	--	--	--	--
Fine aggregate (-3/8 inch)[6]	--	--	2,512	10,726	--	--	20	131
Coarse and fine aggregates[7]	137	W	16,461	32,186	60	W	3,355	7,509
Other construction	--	--	--	--	--	--	35	49
Agricultural[8]	--	--	165	361	--	--	--	--
Chemical and metallurgical[9]	--	--	5,606	13,709	--	--	--	--
Special[10]	--	--	[5]	[5]	--	--	--	--
Other miscellaneous	--	--	293	6,039	--	--	209	225
Other unspecified[11]	122	W	5,690	18,956	72	W	663	1,853
Total[12]	258	W	40,597	124,224	142	W	4,281	9,768

W Withheld to avoid disclosing company proprietary data.

[1]Includes riprap and jetty stone and filter stone.

[2]Withheld to avoid disclosing company proprietary data; included with "Other construction."

[3]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."

[4]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.

[5]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[6]Includes stone sand (concrete and bituminous mix or seal), fine aggregate (screen), and fine aggregate (screening, undesignated).

[7]Includes graded road base or subbase, unpaved road surfacing, dam construction, and crusher run or fill or waste.

[8]Includes agricultural limestone and poultry grit and mineral food.

[9]Includes cement manufacture, lime manufacture, flux stone, chemical stone for alkali works, disinfectant and animal sanitation, glass manufacture, and sulfur oxide removal.

[10]Includes mine dusting, asphalt filler, whiting or whiting substitute, other fillers or extenders, paper manufacture, and roofing granules.

[11]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[12]Data may not add to totals shown because of independent rounding.

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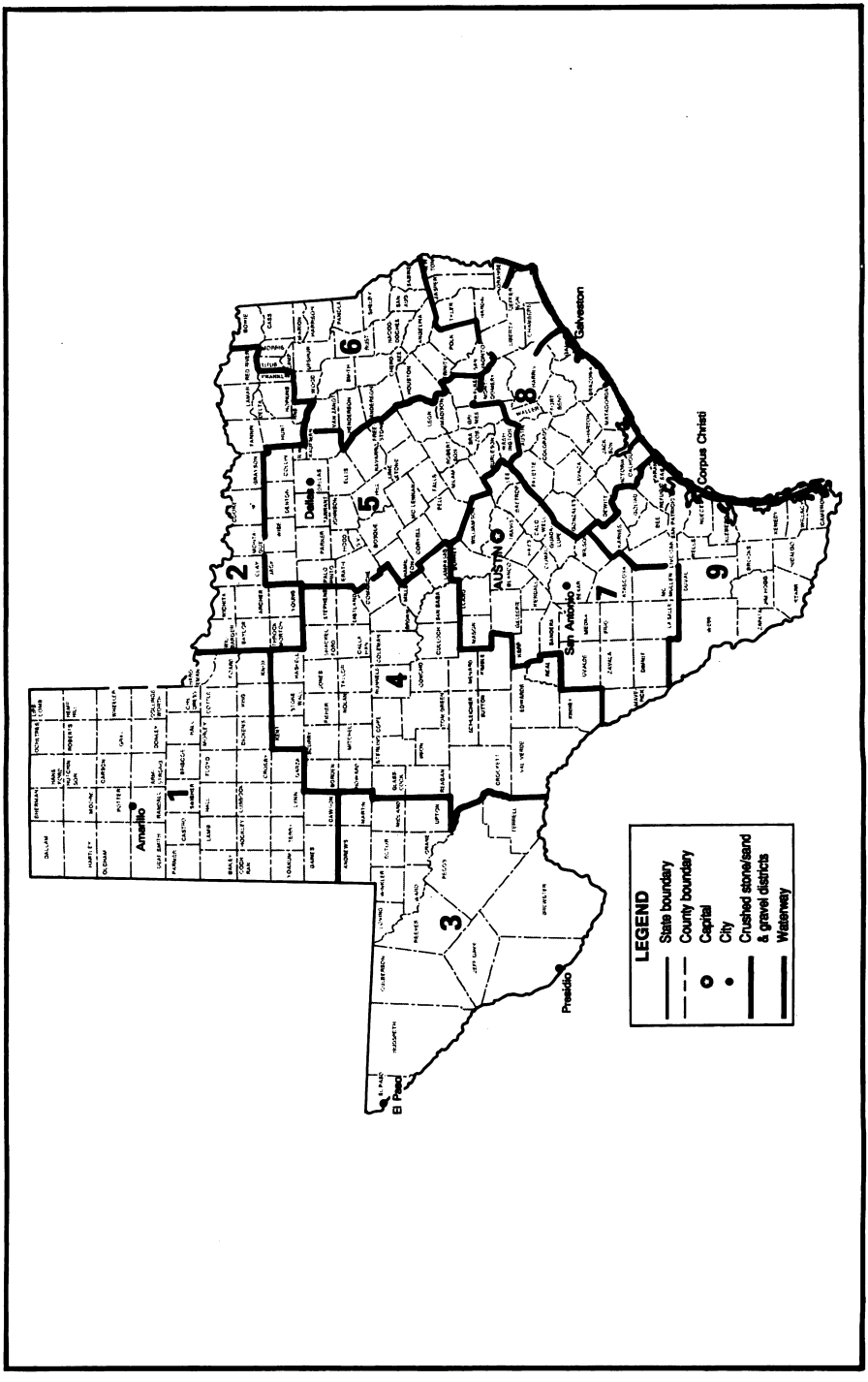

Figure 1.—Aggregate-producing districts in Texas.

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Dimension.—Output of dimension stone climbed 108% over that of 1985 and 53% over that estimated for 1986. Price, however, plunged from approximately $311 per short ton in 1985 and $314 in 1986 to $134 in 1987. Eighteen quarries were operated in 1987. Quarries in Burnet, Gillespie, Llano, and Williamson Counties produced dimension granite; quarries in Burnet, Jones, and Williamson Counties produced dimension limestone.

In decreasing order of output, dimension stone was used for cut and veneer stone, irregular-shaped stone, dressed monumental stone, sawed stone or blocks, rough blocks, rough monumental stone, and dressed flagstone.

Other Industrial Minerals.—Crude and byproduct gypsum were produced in Texas and calcined to make wallboard and other items. Standard Gypsum Co., Dallas, bought Windsor Gypsum Co. of McQueeney. The transaction included Windsor's quarry in Gillespie County, a wallboard plant in Guadalupe County, and a byproduct gypsum and wallboard operation in Rusk County. Only the Gillespie County quarry was operated under the Standard Gypsum name, and only Windsor Gypsum Co. in Rusk County reported calcining gypsum from byproduct rather than crude gypsum. Gypsum also was calcined by other firms at plants in Fisher, Guadalupe, Hardeman, Harris, and Nolan Counties. The Nolan County gypsum quarry and wallboard plant of Genstar Gypsum Co. was sold to Domtar Gypsum Inc.

Plants in Hansford and Moore Counties produced crude and Grade-A helium. Production and total value of crude helium rose more than 28% from 1986 and 52% from 1985. Grade-A helium output and value, however, declined more than one-third.

Seven expanded perlite plants operated in 1987. The value of expanded perlite sold was down about 9%, and output decreased more than 18%. No perlite was mined in Texas. Nord Perlite Co. acquired the Siliflo Inc. expanding plant at Fort Worth, Tarrant County.

Texas output accounted for more than one-fifth of the Nation's salt. The Dow Chemical Co. was the State's largest salt producer. Dow solution-mined salt from an underground mine. The salt brine was used as feedstock to produce chlorine-based and caustic soda-based compounds. Six other firms operated salt-producing facilities in Chambers, Duval, Ector, Fort Bend, Harris, Jefferson, Matagorda, and Van Zandt Counties.

Ozark-Mahoning Co. produced sodium sulfate at its Brownfield and Seagraves plants from brines that underlie three playa lakes in the Texas Panhandle. Sodium sulfate was used in glass container, flat glass, and fiberglass manufacture.

Pennzoil Sulphur Co. in Culberson County and Texasgulf Chemicals Co. in Wharton County operated Frasch sulfur mines in Texas. Frasch sulfur production, sales, and total value decreased significantly from figures reported in 1986. Elemental sulfur was recovered during petroleum refining at plants in 27 counties. The 6 top-ranking of the 27 counties were Harris, Galveston, Nueces, Jefferson, Van Zandt, and Henderson. Because elemental sulfur is a byproduct of petroleum processing, it is not included in table 1; its value in Texas, the leading State in production of recovered sulfur, was greater than $134 million. Byproduct sulfuric acid (100% basis), recovered from copper refineries in the State, increased 9% over that of 1986.

Texas talc and pyrophyllite output ranked third highest among 10 producing States, but production fell nearly 10% from that of 1986 and the price per short ton declined $5.63 to $17.18. Culberson and Hudspeth Counties were the sites of five talc mines: Tumbledown Mine (Culberson County) and Allamore pits, Apache pit, Pioneer pit, and T P claims 1 and 2 (all in Hudspeth County).

W. R. Grace & Co. exfoliated vermiculite for use in concrete and plaster aggregates, block and loose-fill insulation, horticulture agriculture, and fireproofing. The firm operated facilities in Bexar and Dallas Counties.

METALS

Aluminum.—Primary aluminum production in Texas rose nearly 12% while total value fell less than 0.5%. Aluminum Co. of America restarted 105,000 tons of annual capacity at its Rockdale plant, attributing the decision to high metal prices and the inability to sell unused power dedicated to the smelter.

Alumax Inc., a wholly owned subsidiary of AMAX Inc., closed its aluminum extrusion plant at Rockwall, near Dallas, laying off 227 employees at yearend. The company cited the area's depressed business conditions and unacceptable losses as reasons for the decision. The extrusions produced were reportedly for the housing industry, which had been in the doldrums for 3 years.

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Alumax also operated a 75,000-ton-per-year container sheet plant and related recycling and casting facility in Texarkana, Bowie County.

Other Metals.—Laurel Industries Inc. operated its primary antimony refinery at La Porte, Harris County. The plant produced antimony oxide from crude antimony oxide imported from the Republic of South Africa and Bolivia or from antimony metal imported from China. Antimony oxide is used as a fire retardant in plastics, synthetic and natural fibers, rubber, and paper products.

Mathis & Mathis Mining & Exploration Co. and Hudson Bros. Mining Co. Inc. reported limited activities at their limonite-siderite mines and plants. Hudson Bros. reported no mining but it made shipments from stock during 1987.

Magnesium metal production increased insignificantly over that of 1986 but total value dropped approximately 9%.

The steel industry in Texas was hit hard by the reduction in oil well drilling when the price per barrel of oil fell sharply in 1986. Consumption of pig iron nationally rose nearly 10% over that of 1986, but consumption in Texas fell 65%. During the year, USX Corp. closed its Baytown steel plate mill.

The Nation's only tin smelter, operated by TexTin Corp. in Texas City, increased tin metal output. The smelter recovered tin primarily from imported and domestic concentrates and from its own stockpile of tin residues and slags. The smelter's main source of tin concentrates was Peru. TexTin is a subsidiary of Gulf Chemical & Metallurgical Co., which was in turn a subsidiary of Associated Metals & Minerals Corp.

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[1]State Mineral Officer, Bureau of Mines, Denver, CO.
[2]Geologist, Bureau of Economic Geology, The University of Texas at Austin, TX.
[3]Rubin, J. N., J. G. Price, C. D. Henry, and D. W. Koppenaal. Cryolite-bearing and Rare Metal-Enriched Rhyolite, Sierra Blanca Peaks, Hudspeth County, Texas. U.S. BuMines Mineral Institute Report MIR 11-88; also in Am. Miner., v. 72, 1987, pp. 1122-1130.
[4]Rubin, J. N., J. G. Price, C. D. Henry, T. L. Pinkston, D. W. Koppenaal, S. B. Peterson, H. M. Harlan, W. T. Miller, R. J. Thompson, R. B. Grabowsky, D. P. Laybourn, G. E. Schrock, A. Johnson, D. G. Staies, R. B. Gaines, and F. H. Miller. Mineralogy of Beryllium Deposits Near Sierra Blanca, Texas. In Torma, A. E., and I. H. Gundiler, eds. Precious and Rare Metals Technologies. Elsevier, Amsterdam, The Netherlands, 1988, pp. 601-614.

Table 6.—Texas: Primary smelters, refineries, and reduction plants

Product, company, plant	Location (county)	Material treated
Aluminum:		
Aluminum Co. of America:		
Point Comfort	Calhoun	Bauxite.
Rockdale (reduction)	Milam	Alumina.
Reynolds Metals Co.:		
Sherwin plant (alumina)	San Patricio	Do.
Antimony:		
ASARCO Incorporated:		
El Paso smelter	El Paso	
Cadmium:		
ASARCO Incorporated:		
El Paso smelter	do	
Copper:		
ASARCO Incorporated:		
Amarillo refinery[1]	Potter	Blister and anode.
El Paso smelter	El Paso	Ore and concentrates.
Phelps Dodge Refining Corp.:		
Nichols refinery[2]	do	Blister and anode.
Magnesium:		
The Dow Chemical Co.:		
Freeport plant, electrolytic	Brazoria	Seawater.
Tin:		
TexTin Corp.:		
Texas City smelter	Galveston	Ore and concentrates.

[1]Asarco's Amarillo refinery also produced gold, nickel sulfate, palladium, platinum, selenium, silver, and tellurium.
[2]Phelps Dodge's El Paso (Nichols) refinery also produced copper sulfate, gold, palladium, platinum, selenium, silver, and tellurium.

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Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Alamo Cement Co	Box 34807 San Antonio, TX 78233	Quarry and plant	Bexar.
Centex Cement Corp	4600 Republic Bank Tower Dallas, TX 75201	Quarries and plant	Hays and Nueces.
Gifford-Hill & Co. Inc.[1]	Box 520 Midlothian, TX 76065	Quarry and plant	Ellis.
Lafarge Corp.[2]	3333 Fortworth Ave. Dallas, TX 75211	Quarries and plant	Comal, Dallas, Tarrant.
Southwestern Portland Cement Co.[3]	Box 1547 Odessa, TX 79760	do	Ector, El Paso, Potter.
Texas Industries Inc.[4]	8100 Carpenter Freeway Dallas, TX 75247	do	Comal and Ellis.
Clay and shale:			
Acme Brick Co., a division of Justin Industries Inc.	Box 886 Denton, TX 76201	Pits and plants	Denton, Guadalupe, Nacogdoches, Parker, Van Zandt, Wise.
Featherlite Building Products Corp.	Box 141 Ranger, TX 76470	Pit and plant	Eastland.
Wolff Inc	Box 34870 San Antonio, TX 78265	do	Guadalupe.
Gypsum:			
Domtar Gypsum Inc	Box 720 Sweetwater, TX 79556	Quarry and calcining plant.	Nolan.
Georgia-Pacific Corp	900 SW. Fifth Ave. Portland, OR 97204	do	Hardeman.
National Gypsum Co., Gold Bond Div.	2001 Rexford Rd. Charlotte, NC 28211	Quarries and calcining plants.	Fisher, Kimble, Stonewall.
Standard Gypsum Co	Box 27 Fredericksburg, TX 78624	do	Gillespie and Guadalupe.
USG Corp. (formerly United States Gypsum Co.)	101 South Wacker Dr. Chicago, IL 60606	Quarry and calcining plant.	Harris and Nolan.
Lime:			
APG Lime Corp	Route 6, Box 662 New Braunfels, TX 78132-5011	Plant	Comal.
Austin White Lime Co	Box 9556 Austin, TX 78766	Quarry and plant	Bosque and Travis.
Chemical Lime Co	Box 427 Clifton, TX 76634	Plant	Bosque.
Holly Sugar Corp	Drawer 1778 Hereford, TX 79045	do	Deaf Smith.
Redland Worth Corp	Route 2, Box 222 San Antonio, TX 78229	Quarry and plant	Bexar.
Round Rock Lime Co., a subsidiary of Dravo Lime Co.	Box 38 Blum, TX 76627	Plant	Hill.
Texas Lime Co., a subsidiary of Rangaire Corp.	Box 851 Cleburne, TX 76031	Quarry and plant	Johnson.
Salt:			
Occidental Chemical Corp	Box 809050 Dallas, TX 75380	Underground mine	Chambers.
The Dow Chemical Co.[5]	2020 Dow Center Midland, MI 48640	Brine	Brazoria.
Morton Thiokol Inc	110 North Wacker Dr. Chicago, IL 60606	Underground mine and brine.	Van Zandt.
Texas Brine Corp	2000 West Loop South Suite 990 Houston, TX 77027	Brine	Harris, Jefferson, Matagorda.
Sand and gravel:			
Construction:			
Capitol Aggregates Inc. (H. B. Zachry Co.)	Drawer 33240 San Antonio, TX 78265	Stationary plants	Bexar, Travis, Val Verde.
Centex Materials Inc	Drawer 928 Buda, TX 78610	Pits and plants	Hays and Travis.
El Paso Sand Products Inc.[6]	Box 9008 El Paso, TX 79982	do	El Paso.
The Fordyce Co	Box 1981 San Antonio, TX 78297	do	Hidalgo and Victoria.
Ideal Basic Industries Inc., Thorstenberg Materials Co. Inc.	363 North Belt Houston, TX 77054	Pits	Colorado and Fayette.
Parker Bros. & Co. Inc	Box 107 Houston, TX 77001	Stationary plants and dredges.	Colorado, Fayette, Harris.
Pioneer Concrete of Texas Inc.[7]	Box 12449 Dallas, TX 75225	Pits and plants	Colorado, Liberty, Montgomery.

See footnotes at end of table.

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Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Industrial:			
Oglebay Norton Co., Texas Mining Co.	2104 East Randol Mill Rd. Suite 101 Arlington, TX 76011	Pits and plant	McCulloch.
UNIMIN Corp	50 Locust Ave. New Canaan, CT 06840	Plant	Johnson.
U.S. Silica Co	Box 187 Berkeley Springs, WV 25411	Pits and plants	Limestone, Live Oak, McCulloch.
Sodium sulfate (natural):			
Ozark-Mahoning Co	1870 South Boulder Tulsa, OK 74119	do	Gaines and Terry.
Stone:			
Redland Worth Corp	Route 2, Box 222 San Antonio, TX 78229	Plants and quarries	Bexar, Limestone, San Patricio.
Parker Bros. & Co. Inc	Box 107 Houston, TX 77001	Plant and quarries	Comal.
Texas Crushed Stone Co	Box 1000 Georgetown, TX 78626	Plant and quarry	Williamson.
Vulcan Materials Co.[8]	Box 13010 San Antonio, TX 78213	Plants and quarries	Bexar, Brown, Grayson, Parker, Taylor, Uvalde, Williamson, Wise.
Sulfur:			
Byproduct:			
Amoco Production Co. (Standard Oil Co., Indiana)	Box 591 Tulsa, OK 74102	Secondary recovery	Andrews, Ector, Galveston, Hockley, Van Zandt, Wood.
Chevron U.S.A. Inc	575 Market St. San Francisco, CA 94105	do	Crane, El Paso, Hopkins, Jefferson, Karnes.
Exxon Chemical Americas	Box 77253-3272 Houston, TX 77079	do	Atascosa, Crane, Harris.
Phillips Petroleum Co	Bartlesville, OK 74003	do	Andrews, Brazoria, Crane, Hopkins, Hutchinson.
Smackover Shell Ltd	Route 2, Box 152 Eustace, TX 75124	do	Henderson.
Texaco Producing Inc	Box 8 Scroggins, TX 75480	do	Franklin, Freestone, Jefferson.
Native:			
Pennzoil Sulphur Co	1906 First City National Bank Houston, TX 77002	Frasch mine	Culberson.
Texasgulf Chemicals Co., a subsidiary of Elf Aquitaine Inc.	Glenwood at Glen Eden Box 30321 Raleigh, NC 27622-0321	do	Wharton.
Talc:			
Clark Minerals Inc	1000 Coolidge St. South Plainfield, NJ 07080	Pits and plant	Hudspeth.
Dal Briar Corp. (Dal-Tile)	Box 17130 Dallas, TX 75217	Pits	Do.
The Milwhite Inc	Box 15038 Houston, TX 77020	Mine and plant	Culberson.
Southern Clay Products Inc.[9]	Box 44 Gonzales, TX 78629	Pit and plant	Hudspeth.
Vermiculite (exfoliated):			
W. R. Grace & Co	2651 Manila Rd. Dallas, TX 75200	Exfoliating plants	Bexar and Dallas.
Vermiculite Products Inc	Box 7327 Houston, TX 77008	Exfoliating plant	Harris.

[1]Also clays, Ellis County; sand and gravel, Brazos, Dallas, Ellis, and McLennan Counties; and crushed stone, Comal, Cooke, Ellis, Limestone, Walker, and Wise Counties.
[2]Also clays, Dallas County; sand and gravel, Dallas, Johnson, Tarrant, and Wise Counties; and stone, Dallas, Tarrant, and Wise Counties.
[3]Also clays, Potter County.
[4]Also clays, Ellis, Fort Bend, Guadalupe, Henderson, Navarro, and Van Zandt Counties; sand and gravel, Dallas, Ellis, Parker, Travis, and Wise Counties; and crushed stone, Comal, Ellis, Jack, and Wise Counties.
[5]Also magnesium compounds and magnesium chloride for magnesium metal, Brazoria County.
[6]Also crushed stone, Hudspeth County.
[7]Also crushed stone, Burnet and Parker Counties; industrial sand, Colorado and Liberty Counties.
[8]Also industrial sand, McCulloch County.
[9]Also clays, Gonzales County.

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The Mineral Industry of Utah

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineral Survey, for collecting information on all nonfuel minerals.

By Lorraine B. Burgin[1]

The value of nonfuel mineral production increased from $374 million in 1986 to $700 million in 1987. The nearly 87% rise was attributed to increases in copper, gold, and silver prices, and more directly, to resuming operations at the BP America Inc. Bingham Canyon Mine, formerly Kennecott's Utah Copper Div. Metal production rose from nearly one-half the total value of nonfuel minerals in 1986 to more than two-thirds in 1987.

Table 1.—Nonfuel mineral production in Utah[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrates ____short tons	5,738	$6	6,533	$7	6,062	$6
Cement (portland) _ thousand short tons	W	W	1,014	58,431	935	50,565
Clays ____do____	332	2,509	305	2,048	315	1,959
Gem stones	NA	e80	NA	96	NA	105
Gold (recoverable content of ores, etc.) troy ounces	135,489	43,039	W	W	W	W
Gypsum ____ thousand short tons	r274	r2,942	r284	r2,478	W	W
Lime ____do____	225	11,912	232	13,079	562	17,894
Salt ____do____	1,057	30,013	1,112	31,830	1,108	34,264
Sand and gravel:						
Construction ____do____	e14,000	e36,400	16,452	39,763	e21,000	e56,700
Industrial ____do____	W	W	6	123	6	11
Stone:						
Crushed ____do____	4,657	14,180	e4,500	e14,100	7,989	23,606
Dimension ____do____	W	W	W	W	2	93
Vermiculite ____do____	--	--	W	153	--	--
Combined value of asphalt (native, 1985-86), cement (masonry), copper, iron ore (usable, 1986-87), magnesium compounds, magnesium metal (1986-87), mercury (1986-87), molybdenum (1985, 1987), phosphate rock, potassium salts, silver, sodium sulfate (natural, 1985-86), vanadium (1986-87), and values indicated by symbol W	XX	171,792	XX	r212,330	XX	514,661
Total	XX	r312,873	XX	r374,438	XX	699,864

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in Utah in 1986, by county[1]

County	Minerals produced in order of value
Box Elder	Sand and gravel, salt, clays.
Cache	Sand and gravel.
Carbon	Do.
Davis	Do.
Duchesne	Do.
Emery	Do.
Garfield	Do.
Grand	Potassium salts, salt.
Iron	Silver, iron ore, sand and gravel, gold.
Juab	Cement, sand and gravel, gypsum, clays.
Kane	Sand and gravel.
Millard	Lime, sand and gravel, beryllium.
Morgan	Cement.
Rich	Sand and gravel.
Salt Lake	Copper, cement, sand and gravel, salt, gold, vermiculite, silver.
Sanpete	Sand and gravel, clays, gypsum.
Sevier	Gypsum, salt, clays, sand and gravel.
Summit	Clays, sand and gravel.
Tooele	Gold, salt, magnesium compounds, potassium salts, sand and gravel, clays, silver.
Uintah	Phosphate rock, sand and gravel.
Utah	Sand and gravel, clays.
Wasatch	Sand and gravel.
Washington	Do.
Wayne	Do.
Weber	Salt, sodium sulfate, magnesium compounds, sand and gravel, clays.
Undistributed[2]	Stone (crushed), asphalt, vanadium, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Nationally, in value of production, Utah ranked first in native asphalt (gilsonite), gallium, and beryllium-containing ores; second in potash; third in copper, magnesium, and vanadium; fourth in gold, phosphate rock, and silver; and fifth in molybdenum. Utah continued as the only State producing gallium and gilsonite and was one of three States with output of potash, magnesium, and vanadium.

Trends and Developments.—Nationwide, the State's ranking in value of nonfuel mineral production rose from 22d in 1986 to 13th in 1987. Generally higher metal prices and a full year of production after the 1985-86 shutdown of the State's principal producer of copper and byproduct gold, molybdenum, and silver were the chief factors in the increase. The price gain occurred when many companies cut back production and stocks of refined metal dwindled to their lowest point in many years while demand remained strong.

Of major economic importance to the State was the purchase and startup of the Geneva Works steel plant, idle since August 1986. Basic Manufacturing and Technologies of Utah Inc. (BMT) acquired the plant from USX Corp. in August, renamed the operation "Geneva Steel of Utah," and resumed production in the third quarter. The aging facility, constructed during World War II, faced an uncertain future in 1985, when USX announced a joint-venture agreement with Pohang Iron and Steel Co. Ltd. (POSCO), Republic of Korea, to supply semifinished coil to the USS-POSCO Industries modernized plant at Pittsburg, CA, beginning October 1989. For years, the USX Pittsburg plant had been the market for most of the Geneva Works output; however, the new company established other markets and, by yearend, had full order books.

Production of vanadium, a byproduct of uranium output on the Colorado Plateau, continued to decline because of depressed prices and competition from imports of uranium.

Increases in value were posted for magnesium compounds, phosphate rock, potassium salts, salt, construction sand and gravel, and crushed stone. Although F. W. Dodge statistics indicated significant declines in total residential and nonresidential construction, 22.7% and 27.2%, respectively, nonbuilding construction (roads, highways, dams, bridges, powerplants, etc.) increased 53.3%. This accounted, in part, for the gain in construction sand and gravel and crushed stone production.[2] Major components of the latter increase were the dikes built to enclose excess Great Salt Lake waters in the West Desert pond, and construction on dams, roads, and highways.

Legislation and Government Programs.—Since 1979, the U.S. Bureau of

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Mines, in accordance with the Federal Land Policy and Management Act of 1976 (Public Law 94-579), has assessed the mineral values of the U.S. Bureau of Land Management managed lands that are being proposed for inclusion in the National Wilderness Preservation System. In 1987, the Bureau of Mines placed 13 reports on open file: Wah Wah Mountains, Beaver and Millard Counties; Diamond Breaks, Moffat County, CO/Daggett County, UT; Steep Creek, Garfield County; Bull Mountain/Mount Hillers, Garfield and Wayne Counties; Cottonwood Canyon/Red Mountain, Washington County; Black Ridge Canyons/Black Canyons West and Westwater Canyon, Mesa County, CO, and Grand County, UT; North Stansbury, Tooele County; Notch Peak and Swasey Mountain/Howell Peak, Millard County; Horsheshoe Canyon, Emery and Wayne Counties; Cockscomb/Wahweap, Kane County; Lost Spring Canyon, Emery and Wayne Counties; Cockscomb/Wahweap, Kane County; Lost Spring Canyon, Grand County; and certain areas adjacent to Zion National Park.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Beryllium.—Beryllium ore production declined in quantity and value; Brush Wellman Inc. continued as the principal source of beryllium ores in the United States. The bertrandite ores were surface mined at the Topaz-Spor Mountain area, Juab County, and trucked to the processing plant near Delta, Millard County, where a hydrometallurgical process was used to extract beryllium hydroxide. The plant's product was shipped to Ohio to be converted to beryllium, berylium alloys, and beryllia ceramic. Domestic and imported beryl ores were also treated at the Delta plant. Cominco American Incorporated-Beryllium International Corp. conducted feasibility studies for an operation in the Topaz Mountain area where ore reserves adjacent to Brush Wellman properties were reported to be 500,000 short tons containing 0.64% beryllium oxide.[3]

Copper.—Copper output increased dramatically with the first full year of production since low metal prices shut down the Bingham Canyon Mine, the State's only active copper producer. Posted Metals Week producer prices for copper cathode rose from an average 66.052 cents per pound in 1986 to 82.498 cents per pound in 1987. Prices for 1987 ranged from a low of 64.387 cents per pound to a high of 150.77 cents per pound.[4]

The Bingham Canyon operation is the world's deepest open pit copper mine. Nationally, in 1987, the mine ranked third in copper output and sixth in gold. According to the British Petroleum Co. p.l.c. 1987 20-F Annual Report to the Securites and Exchange Commission, the operation milled about 23,447,000 short tons of ore containing 152,000 tons of copper, 199,000 troy ounces of gold, 1,788,000 troy ounces of silver, and 5,014,000 pounds of molybdenum.

As of December 31, 1987, British Petroleum estimated Bingham Canyon reserves to be 746 million tons, minable by open pit, and averaging 0.705% copper, 0.014 ounce of gold, 0.097 ounce of silver, and 0.053% molybdenum per ton. Reserves minable by underground methods were an estimated 89 million tons averaging 2.81% copper, 0.046 ounce of gold, 0.61 ounce of silver, and 0.017% molybdenum per ton.

The Bingham Canyon Mine ownership was significantly restructured during the year. In 1981, Kennecott became a subsidiary of Standard Oil Co., Ohio, 55% owned by British Petroleum. In 1987, British Petroleum acquired the remaining 45% of Standard Oil and reorganized Kennecott and its Amselco Minerals Inc. into a single subsidiary, BP Minerals America Inc., headquartered in Salt Lake City.

The $400 million modernization program approved by Standard Oil in late 1985 continued, with completion scheduled for late 1988. In place by yearend 1987 was a seven-story in-pit crusher capable of handling 10,000 tons per hour and a 5-mile conveyor system to replace the railroad and carry ore from the pit to the new 77,000-short-ton-per-day concentrator at Copperton. Construction on the Copperton facilities included installing three semiautogenous (SAG) mills in the grinding plant and 63 Wemco flotation cells (thirty-three 3,000-cubic-foot cells, largest in the industry; sixteen 1,000-cubic foot cells; and fourteen 500-cubic foot cells) in the copper circuit of the adjacent flotation plant. Copper concentrates would be transported 17 miles directly to the Garfield smelter via a 6-inch steel-lined pipeline; a 48-inch concrete pipeline

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would deliver tailings to the 5,500-acre tailings area at Magna. The modernization program was expected to save the company $85 million per year in overall operating costs.

The new operation was expected to require fewer employees. About 7,400 workers were employed at the Utah Copper Div. in 1981; with the decrease in copper production and resulting layoffs, the work force was reduced to 2,300. At the end of the modernization project, employment will be further trimmed to 1,800.[5]

The company predicted that after completing the modernization program in 1988, the mine would become the lowest cost producer in North America and one of the lowest cost producers in the world.

Gallium and Germanium.—Production of gallium metal increased in quantity and value; no germanium was recovered. On September 1, St. George Mining Corp., a subsidiary of Musto Exploration Ltd., Vancouver, British Columbia, Canada, idled its mine and extraction plant for at least 4 months. Technical problems with the germanium refinery, weak gallium prices, and financial difficulties caused the shutdown of the Nation's only primary gallium-germanium refinery.

Gold.—Gold output more than doubled as production at Bingham Canyon was restored and the Trixie Mine resumed shipping its flux ore to the Garfield smelter. The value of production trebled with the increase in production and with the rise in the price of gold from an average $368.24 per ounce in 1986 to $447.95 in 1987. Gold producers in the State included American Barrick Resources Corp.'s, Barrick Mercur Gold Mine, BP Minerals' Bingham Canyon Mine, Hecla Mining Co.'s Escalante Mine, and Sunshine Mining Co.'s Trixie Mine.

Barrick Mercur, the State's second-ranking gold producer, mined a lower grade ore, and production declined to 108,272 ounces of gold with 96,870 ounces from the mill and 11,402 from the dump leach. The company milled 1.6 million tons of ore averaging 4,454 tons per day. A $9.6 million, 750-ton-per-day pressure oxidation plant was under construction to oxidize refractory sulfide ore stockpiled since open pit mining began in 1983. The new plant would use a 46-foot autoclave, 12 feet in diameter, the first alkaline pressure-leaching autoclave installed for treating gold in the United States. At yearend, Mercur's oxide ore reserves were an estimated 12.2 million short tons grading 0.07 ounce of gold per short ton. Oxide leach reserves totaled 8.4 million tons grading 0.033 ounce of gold per ton. Refractory carbonaceous sulfide ore reserves totaled an estimated 5.7 million short tons grading 0.059 ounce of gold per ton.[6]

Iron Ore and Steel.—Gilbert Development Corp. shipped iron ore from the Iron Springs district, southwest of Cedar City, Iron County, to the reopened and renamed Geneva Steel of Utah plant near Provo. USX's USS Minntac Mine in Minnesota, provided most of the plant's iron ore, which was shipped in pellets averaging 65.5% iron on a dry basis.

In February, USX announced its USS' Geneva Works near Provo would be indefinitely idled and, on April 2, the company announced its Utah steel plant would be permanently closed, effective July 1. USX negotiated the sale of its Geneva Works to a group of Utah investors, BMT. The sale depended on the group's obtaining financing and reaching a successor union labor agreement. The new labor agreement reached in midyear allowed for profit sharing. On August 31, BMT purchased the steel works for more than $40 million. USS had kept the plant on "hot idle," at a reported cost of $3 million per month; the new company started up the operation on September 1. On October 3, 12,000 tons of rolled coils were transported to Texas, the first shipment from the plant in 13 months. By yearend, 1,600 workers were employed and plans were to expand annual production from the projected 680,000 tons per year to more than 1 million. USS Geneva's output had been between 1.2 million to 1.5 million tons, with 70% going to its Pittsburg plant and 30% to an outside market.

Nucor Steel Div. of Nucor Corp. operated a 400,000-short-ton-per-year steel minimill at Plymouth, Box Elder County. At the plant, an electric arc furnace melted scrap steel for processing by continuous-casting equipment. Nucor's Utah production capacity increased to about 600,000 tons per year with the startup of a major expansion in the third quarter of 1987. Nucor Steel's Vulcraft, Cold Finish, and Grinding Ball divisions continued production of various products at Brigham City.

Magnesium.—Magnesium output declined in quantity and value at the AMAX Magnesium Corp. plant at Rowley, Tooele County. The company, a subsidiary of AMAX Inc., continued to purchase brines for the production of magnesium metal from Kaiser Aluminum & Chemical Corp.,

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Wendover, and from Leslie Salt Div. of Cargill Inc., Newark, CA. In June, AMAX contracted with Morrison-Knudsen Engineers, Boise, ID, to construct a new solar evaporation system on 58,000 acres on desert lands north of Knolls, Tooele County, and west of Great Salt Lake to replace company evaporation ponds destroyed by a June 1986 storm on Great Salt Lake. Lake waters would be brought to the new pond system from a 500-square-mile, 2.5-foot-deep pond created by the State to lower the level of Great Salt Lake. Utah's $60 million West Desert pumping project, which included installation of three record-size centrifugal pumps, was expected to reduce the lake level 13 inches from its historic high of 4,211.85 feet above sea level. AMAX Magnesium would pipe the distillate 41 miles to the Rowley magnesium processing plant. Production of brine feedstock from the new $25 million system was expected in the second half of 1988.

Molybdenum.—BP Minerals recovered molybdenum as a byproduct of copper production at its Bingham Canyon operation. The British Petroleum 20-F 1987 Annual Report showed output of contained molybdenum increased from 13,000 pounds in 1986 to 5,014,000 pounds in 1987.

Silver.—Silver production increased about 74% in quantity and value of output more than doubled. Resumption of operations at the BP Minerals Bingham Canyon Mine and the rise in the average unit price of silver from $5.40 per troy ounce in 1986 to $7.01 in 1987 contributed to the dramatic increase in output and value. According to British Petroleum's 20-F 1987 Annual Report, silver production at Bingham Canyon reached 1,788,000 troy ounces.

Hecla Mining's Escalante unit in Iron County remained the largest silver producer in Utah and ranked seventh nationally, while the Bingham Canyon Mine ranked eighth. According to the Hecla 1987 annual report, Hecla produced 2,252,942 ounces of silver in 1987, much the same as its 1986 output. The company reported its present ore body would be mined out by February 1989 unless more ore reserves are found.

Silver was recovered as a byproduct of gold production at the Barrick Mercur Gold Mine, and from the precious metals flux ore shipped by Sunshine Mining's Trixie Mine to the BP Minerals smelter.

Uranium-Vanadium.—Of the States recovering vanadium—Colorado, Idaho, and Utah—Utah ranked third. Output of vanadium recovered as a byproduct of uranium production declined in quantity and value. The White Mesa mill near Blanding, a joint venture of Umetco Minerals Corp. (70%) and Energy Fuels Nuclear Inc. (30%), processed ores primarily for Energy Fuels from its Arizona uranium operations. Umetco Minerals Div. of Union Carbide Corp. reopened a uranium mine near La Sal, San Juan County, to supply uranium ore for its 2,000-ton-per-day mill. The mill produced 4.8 million pounds of uranium oxide and 2.8 million pounds of vanadium pentoxide in 1986.

Because of the continuing depressed condition of the domestic uranium industry, Atlas Minerals Div. of Atlas Corp. permanently closed its uranium mines and processing mill near Moab on June 30, 1987. Sales of uranium inventories and liquidation of uranium assets were expected to cover closing and reclamation costs. The Nuclear Regulatory Commission, in mid-1987, rejected the company's application to renew its Moab uranium-vanadium mill operating license after the company was unable to provide a surety bond for decommissioning, decontaminating, and reclaiming the mill and millsite.

Rio Algom Mining Corp. processed uranium ores, but although vanadium was present in the ores, no vanadium was recovered.

Other Metals.—Mercury was recovered as a byproduct of gold production at the Barrick Mercur Gold Mine. In 1986, Energy Fuels Nuclear purchased the Westinghouse Electric Corp. uranium-scandium recovery plant at the Bingham Canyon Mine. The plant reopened in February 1987 and recovered scandium as a byproduct of uranium processing of copper leach material. Selenium was recovered from anode slimes at the BP Minerals America copper refinery at Garfield. Near Ogden, Western Zirconium Inc. continued producing primary zirconium sponge and coproduct hafnium sponge from zircon concentrates imported from Australia.

INDUSTRIAL MINERALS

Cement.—Finished portland cement production dropped about 12% and sales continued to decline in quantity and value as residential construction declined. The average price per short ton of finished portland cement sold slumped from $57.63 in 1986 to $54.08 in 1987. Masonry cement output declined; however, sales remained essential-

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ly the same and its value rose. Ideal Basic Industries Inc. was the only producer.

Three companies manufactured and shipped portland cement: Southwestern Portland Cement Co.'s dry-process plant in Juab County near Leamington; Ideal Basic's wet-process plant at Devils Slide, Morgan County; and Lone Star Industries Inc.'s Portland Cement Co. of Utah wet-process plant at Salt Lake City. In October, Lone Star notified its 70 employees that if demand did not improve, production might not be resumed in February 1988, after its traditional winter shutdown. The company would then maintain its terminal in Salt Lake City and transport cement from its plants in other States. In existence since the late 1800's, the Portland Cement Co. of Utah was acquired by Lone Star in 1979. Ideal Basic, 68.2% owned by Holdernam Inc., a wholly owned subsidiary of "Holderbank" Finançiere Glaris Ltd., Switzerland, planned a $6 million modernization project at its Devils Slide cement plant. The plant's capacity was expected to be increased by 50,000 short tons to 400,000. Replacing the old raw grinding system with a 2,000-horsepower cement grinding system would represent the first phase.

Clays.—Although total clay and shale production increased in quantity, its value declined as common clay output dropped in quantity and value. Output of bentonite, however, increased more than threefold in quantity and value. No fire clay was mined in 1987.

Producers of common clay included Interpace Corp., Interstate Brick Co., Southwestern Portland Cement, and Utelite Corp. Swelling bentonite was mined by Redmond Clay and Salt Co. at its pits in Sanpete and Sevier Counties and Western Clay Co. at its pit in Sevier County.

The common clays were used mainly for manufacturing face brick, in lightweight aggregate for concrete block and structural concrete, and in cement. Swelling bentonite was used for animal feed, drilling mud, and waterproof sealant.

Graphite (Synthetic).—Hercules Inc., Aerospace Div., produced synthetic graphite high-modulus fibers at its Bacchus Works near Salt Lake City. More than 4,000 workers were employed to manufacture solid-propellant rocket motors, graphite materials, and structures such as experimental, solid-propellant-rocket motor cases. Production of synthetic graphite increased more than 18% in quantity and about 14% in value. To verify compliance with a United States-Soviet Union agreement to eliminate medium- and short-range missiles, the Soviet Union elected to inspect the Bacchus plant, similar to the Soviet facility at Votkinsk, U.S.S.R.

Gypsum.—Georgia-Pacific Corp. and United States Gypsum Co., a subsidiary of USG Corp., produced crude and calcined gypsum. Gypsum was open pit mined northeast of the companies' crushing and calcining facilities for the manufacture of wallboard at Sigurd, Sevier County. Crude gypsum production declined in quantity as two other 1986 producers idled their operations. Output of calcined gypsum increased about 6% in quantity and 5% in value.

Lime.—Total production of quicklime and hydrated lime gained in quantity and value. Producers included Chemstar Inc., Grantsville, Tooele County; Continental Lime Inc., a subsidiary of Steel Bros. Canada Ltd., Millard County; BP Minerals, Salt Lake County; and Utah Marblehead Lime Co., a subsidiary of United States Pollution Controls Inc. (USPCI), Oklahoma City, OK. The increase in output was attributed, in part, to startup of the BP Minerals America flotation concentrator at Magna and use of the product in western heap-leach gold operations.

Utah Marblehead (former subsidiary of General Dynamic Corp., St. Louis, MO) consolidated and restructured its operations and sold its Utah plant to USPCI, a hazardous waste control company, in the first quarter of 1987. Called Materials Energy Research & Recovery Corp., a subsidiary of USPCI, the new firm planned to convert the facility's two rotary kilns to burn hazardous materials.

Magnesium Compounds.—Production of magnesium chloride brines increased in quantity and value as Kaiser Aluminum & Chemical continued to ship brines from its Wendover plant to the AMAX Magnesium facility at Rowley. Kaiser Aluminum & Chemical, the principal producer of magnesium compounds, recovered the commodity and other products from subsurface brines on the Bonneville Salt Flats. Great Salt Lake Minerals & Chemicals Corp., a subsidiary of Gulf Resources & Chemical Corp., also produced magnesium chloride and other products from the brines of Great Salt Lake west of Ogden, Weber County. The magnesium chloride in bitterns, the final product of the solar evaporation process, was used primarily as a dust suppressant

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for roads and industrial areas and in the sugar beet processing industry.

Phosphate Rock.—Marketable phosphate rock production increased more than 46% in quantity; its value, however, rose only about 9% because of the decline in prices. Chevron Resources continued as the only producer in the State, mining and processing phosphate rock north of Vernal and pumping the slurry 94 miles to the company's fertilizer plant in Rock Springs, WY.

Potash.—Potassium salts were recovered and marketed by Kaiser Chemicals of Kaiser Aluminum & Chemical and Texasgulf Chemicals Co. of Texasgulf Inc. Although total production was down, sales increased nearly 39% in quantity and about 61% in value.

At the Kaiser Chemicals operation near Wendover, subsurface brines containing potassium salts, sodium chloride, and magnesium compounds were collected from the Bonneville Salt Flats of the Great Salt Lake Desert and concentrated in solar evaporation ponds. Potassium salts were then harvested and processed through a flotation concentrator to separate the sodium chloride (halite) and potassium chloride (sylvite). During the year, the company sold the Wendover facility to Reilly Tar and Chemicals Corp.

In August, Texasgulf Inc. (a subsidiary of Elf Aquitaine Inc., a Delaware corporation, in turn owned by Société Nationale Elf Aquitaine of France), concluded an agreement with the Carey Salt Div. of Process Minerals Inc. to form a new company, Moab Salt Inc., effective January 1, 1988. Carey Salt would market the salt products. According to the Elf Aquitaine Inc. 1987 annual report, potash production at the Cane Creek operation near Moab was decreased 51%, to 52,000 short tons, to reduce warehouse inventories. The solution mine produced 344 million gallons of brine, down 47% from 1986. Brines were deposited on solar evaporation ponds, from which the salts were harvested and then processed by flotation for the recovery of potash (sylvite) and a byproduct salt.

Great Salt Lake Minerals ceased production of sulfate of potash after the company's solar evaporation ponds were flooded on May 5, 1984. Repair of physical damage started in 1984 and was finished in 1987. Rebuilding of pond floors was nearly completed by yearend. Partial production of the specialty fertilizer, sulfate of potash, was expected to resume in 1989.

Salt.—Salt production increased 20% and, although sales dipped, the value of that output increased about 8%. Leading salt producers included Great Salt Lake Minerals; American Salt Co., a subsidiary of General Host Corp.; Morton Salt Co., a subsidiary of Morton-Thiokol Inc.; Diamond Crystal Salt Co.; International Salt Co.; Texasgulf Inc.; Redmond Clay & Salt; and Brine Moab Co.

On January 1, Diamond Crystal Salt, St. Clair, MI, purchased the AMAX Inc. Sol-Aire Salt and Chemical Co. for $800,000 and future royalties based on salt shipments. However, in July, severe competition in the marketplace and other factors prompted Diamond Crystal Salt to sell its 101-year-old salt division, including the newly purchased Utah facility, to International Salt Co., a unit of Akzo NV, a Dutch chemical conglomerate. About 50 people were employed at the solar evaporation and refinery facility on the south shore of Great Salt Lake.

Great Salt Lake Minerals sold common salt to the chemical industry and to highway departments for deicing purposes. The plant had the capacity to produce 400,000 tons per year of kiln dried salt for water softening, chemical processing, and other applications. According to the Gulf Resources & Chemical 1987 10K Annual Report, processed salt production was 291,000 short tons and wet salt produced for sale was 220,000 short tons. Elf Aquitaine's 1987 annual report showed salt recovered by solar evaporation was sold from stockpiles; production by its Texasgulf unit totaled 54,944 short tons and shipments were 12% higher than 1986.

W. D. Haden Co. began constructing its Crystal Peak Minerals project on Lake Sevier, Millard County. Salt would be recovered from the lake brines.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel producers continued to face controversy with local residents in the vicinity of proposed or operating pits. For example, Gibbons and Reed Mining Co. wanted to resume mining gravel at a 54-acre site within Highland City; however, the city would not permit a gravel operation within the city limits. Late in the year, the company filed a suit in the Fourth District Court against Highland City, claiming the company was in business at the site before the city was incorporated.

Industrial.—Utah's only industrial sand producer, Salt Lake Valley Sand & Gravel

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Co., marketed the commodity for molding and core and for sand blasting. Production remained essentially the same but value declined.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Crushed stone production increased in quantity and value, partly because of the resumption of Bingham Canyon copper operations, startup of the Geneva Steel of Utah steel plant, construction of ponds in the West Desert area, and other activities. Crushed stone was produced at 33 quarries in 15 counties; the leading county was Box Elder, followed by Salt Lake, Juab, Millard, Tooele, Morgan, and Utah Counties.

Table 3.—Utah: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	3,081	W
Other coarse aggregate	84	106
Coarse aggregate, graded:		
Railroad ballast	150	W
Coarse and fine aggregates:		
Unpaved road surfacing	49	88
Other coarse and fine aggregates	(2)	(2)
Other construction[3]	1,356	11,665
Agricultural: Poultry grit and mineral food	6	98
Chemical and metallurgical:		
Cement manufacture	1,504	4,601
Flux stone	85	(4)
Special: Other miscellaneous[5]	517	3,247
Other unspecified[6]	1,158	3,799
Total[7]	7,989	23,606

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes dolomite, limestone, granite, quartzite, sandstone, volcanic cinder, and scoria and other miscellaneous stone.
[2]Less than 1/2 unit.
[3]Includes filter stone, concrete aggregate (coarse), bituminous surface-treatment aggregate, stone sand (concrete and bituminous mix or seal), graded road base or subbase, terrazzo and exposed aggregate, and crusher run or fill.
[4]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[5]Includes other agricultural uses, lime manufacture, mine dusting and acid water treatment.
[6]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[7]Data may not add to totals shown because of independent rounding.

Table 4.—Utah: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	3,097	W	W	W	(2)	74
Coarse aggregate, graded[3]	W	W	W	W	--	--
Fine aggregate (-3/8 inch)[4]	--	--	W	W	--	--
Coarse and fine aggregates[5]	W	W	W	W	(6)	(6)
Other construction	186	7,458	1,369	4,328	--	--
Agricultural[7]	(8)	(8)	(8)	(8)	--	--
Chemical and metallurgical[9]	(8)	(8)	(8)	(8)	--	--
Special[10]	--	--	(8)	(8)	--	--
Other miscellaneous	1,504	5,700	608	2,246	--	--
Other unspecified[11]	1,125	3,766	--	--	100	33
Total	5,912	16,924	1,977	6,574	100	107

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes riprap and jetty stone, filter stone, and coarse aggregate (large).
[2]Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[3]Includes concrete aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[4]Includes stone sand (concrete and bituminous mix or seal).
[5]Includes graded road base and subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill.
[6]Less than 1/2 unit.
[7]Includes poultry grit and mineral food and other agricultural uses.
[8]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[9]Includes cement manufacture, lime manufacture, and flux stone.
[10]Includes mine dusting.
[11]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three Utah districts depicted in figure 1.

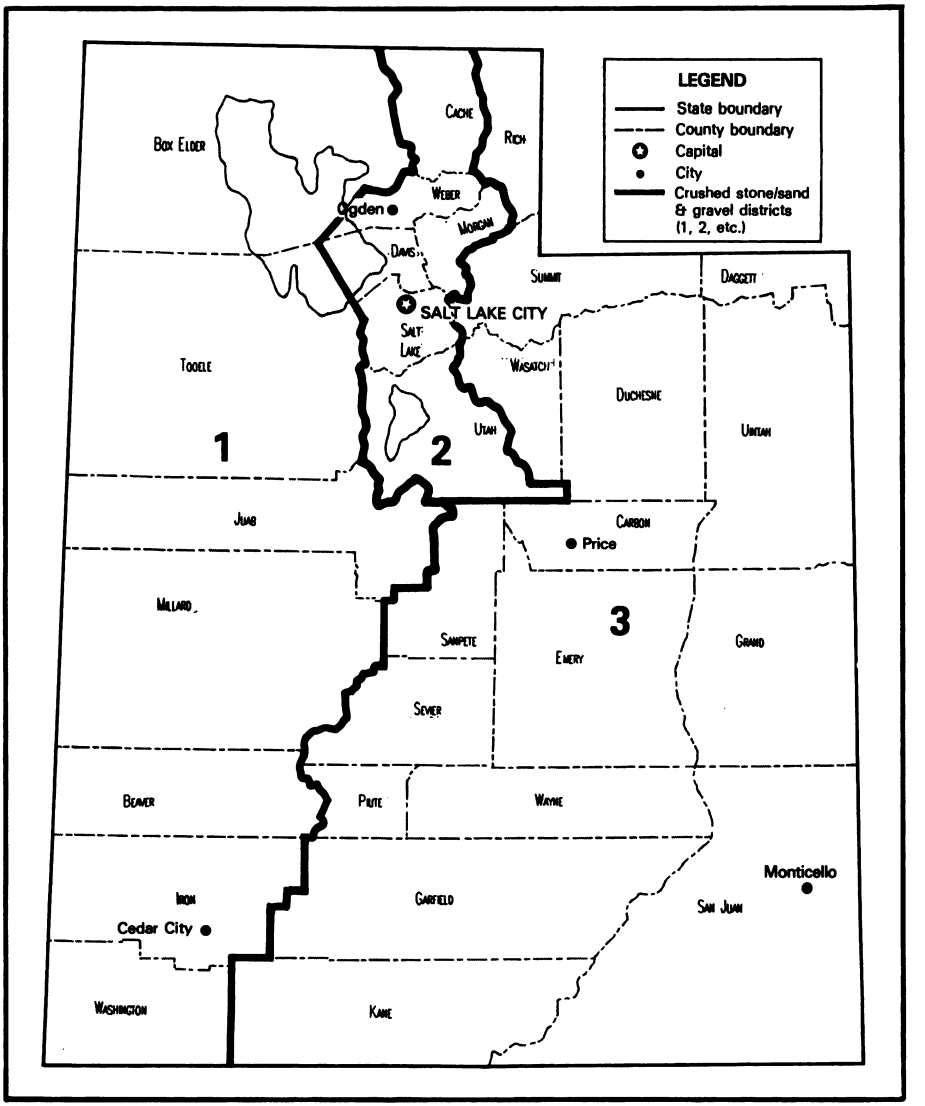

Figure 1.—Aggregate-producing districts in Utah.

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Dimension.—Rocky Mountain Mineral Service Inc., quarried aragonite in Tooele County.

Other Industrial Minerals.—Other industrial mineral commodities produced in the State included gilsonite, a hydrocarbon mined at Bonanza, Uintah County, by American Gilsonite Co., a division of Chevron Resources Co., of Chevron Corp; sulfur recovered by the Chevron Oil Co. refinery in Salt Lake County; sulfuric acid produced as a byproduct of smelting copper by BP Minerals at Garfield; and exfoliated vermiculite produced by Intermountain Products Inc. from crude vermiculite shipped in from out of State.

[1]State Mineral Officer, Bureau of Mines, Denver, CO.

[2]Sargent, A. Construction Suffers Significant Declines in 1987. Utah Construction Report 1987, Bureau of Economic and Business Research, University of Utah, v. 30, No. 4, p. 20.

[3]Farr, P. Beryllium. Min. J. (London), Min. Annu. Rev., June 1988, pp. 86-87.

[4]Metals Week. V. 59, No. 5, Feb. 1, 1988, p. 10.

[5]Walenga, K. Utah Copper—$400 Million Modernization Project Nearing Completion. Rocky Mountain Pay Dirt, No. 101, Feb. 1988, pp. 6A-8A.

[6]White, L. (Ed.). Mercur Starts Up Its New Alkaline Pressure-Oxidation Autoclave Plant. Eng. and Min. J., v. 189, No. 6, June 1988, pp. 26-31.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt:			
American Gilsonite Co., a subsidiary of Chevron Corp.	Kennecott Bldg., Suite 1150 Salt Lake City, UT 84133	Underground mines and plant	Uintah.
Beryllium:			
Brush Wellman Inc.	67 West 2950 South Salt Lake City, UT 84115	Surface mines and plant	Juab and Millard.
Cement:			
Ideal Basic Industries Inc., Cement Div.[1]	Box 8789 Denver, CO 80201	Quarries and plant	Morgan.
Portland Cement Co. of Utah, a division of Lone Star Industries Inc.[1]	Box 90765 Houston, TX 77290	do	Salt Lake and Tooele.
Southwestern Portland Cement Co., a subsidiary of Southdown Inc.[1 2]	Box 21158 Salt Lake City, UT 84121	do	Juab.
Clays:			
Interpace Corp., Structural Div.	Box 9160 Mica, WA 99023	Surface mines and plant	Utah and Weber.
Interstate Brick Co., a subsidiary of Mountain Fuel Co.	9780 South 5200 West West Jordan, UT 84084	do	Box Elder, Piute, Summit, Tooele, and Utah.
Utelite Corp	Box 387 Coalville, UT 84017	Surface mine and plant	Summit.
Western Clay Co.[1]	Box 1067 Aurora, UT 84620	Surface mines	Sevier.
Copper:			
BP Minerals America Inc.[3]	10 East South Temple Box 11248 Salt Lake City, UT 84147	Surface mine, mills, smelter, refinery.	Salt Lake.
Gold:			
Barrick Mercur Gold Mines Inc., a subsidiary of American Barrick Resources Corp.[4]	Box 838 Tooele, UT 84074	Surface mine, mill, carbon-in-pulp plant.	Tooele.
Gypsum:			
Georgia-Pacific Corp	Box 80 Sigurd, UT 84657	Surface mine and plant	Sevier.
United States Gypsum Co., a subsidiary of USG Corp.	Box 120 Sigurd, UT 84657	do	Do.
Iron and steel:			
Geneva Steel of Utah	Box 2500 Provo, UT 84603	Mines and steel plants	Iron and Utah.
Nucor Steel Div., Nucor Corp.	Box 100 Plymouth, UT 84330	Plant	Box Elder.
Lime:			
Continental Lime Inc., a subsidiary of Steel Bros. Canada Ltd.[1]	Box 266 Delta, UT 84624	Quarry and plant	Millard.
Chemstar Inc.[1]	Box 537 Grantsville, UT 84029	Surface mine and plant	Tooele.
Materials Energy Research & Recovery Corp., a subsidiary of United States Pollution Controls Inc. (formerly Utah Marblehead Lime Co.)[1]	Box 596 Grantsville, UT 84029	do	Do.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Magnesium:			
AMAX Magnesium Corp., a subsidiary of AMAX Inc.[7]	238 North 2200 West Salt Lake City, UT 84116	Plant and solar evaporation ponds.	Tooele.
Phosphate rock:			
Chevron Resources Co., a subsidiary of Chevron Corp.	Manila Star Route Vernal, UT 84078	Surface mine and plant	Uintah.
Potassium salts:			
Great Salt Lake Minerals & Chemicals Corp., a division of Gulf Resources & Chemicals Corp.[5 7]	765 North 10500 West Little Mountain Box 1190 Ogden, UT 84402	Plant, concentrator, solar evaporation ponds.	Weber.
Reilly Tar & Chemicals Corp., Reilly Wendover Div. (formerly Kaiser Chemicals of Kaiser Aluminum & Chemical Corp., Bonneville Ltd. Div.)[6 7]	Box 580 Wendover, UT 84083	____do	Tooele.
Texasgulf Inc., a subsidiary of Société Nationale Elf Aquitaine.[7]	Box 1208 Moab, UT 84532	Solution mine, solar evaporation, concentrator, plant.	Grand.
Salt:			
American Salt Co	Box 477 Grantsville, UT 84029	Plant	Tooele.
Morton Salt Co., a division of Morton-Thiokol Inc.	A.M.F. Box 22054 Salt Lake City, UT 84122	____do	Salt Lake.
Sol-Aire Salt & Chemical Co., a division of International Salt Co.	1428 Hardy Rd. Lake Point, UT 84074	Plant	Tooele.
Sand and gravel (construction):			
Concrete Products Co., a division of Gibbons & Reed Co.[2]	41 West Central Ave. Box 7356 Murray, UT 84107	Pits and plants	Davis, Salt Lake, Summit, Utah, Weber.
Geneva Rock Products Inc	1565 West 400 North Box 538 Orem, UT 84057	____do	Salt Lake.
Harper Excavating Inc	4655 West 5415 South Kearns, UT 84118	____do	Do.
Kiewit Western Co	5900 South 370 West Box 7780 Murray, UT 84107	____do	Do.
LeGrand Johnson Construction Inc.	Box 248 Logan, UT 84321	____do	Cache, Juab, Rich.
Monroc Inc	1730 North Beck St. Box 537 Salt Lake City, UT 84110	____do	Salt Lake.
Jack B. Parson Co. Inc	5200 South Washington Blvd. Box 3429 Ogden, UT 84402	____do	Box Elder, Cache, Davis.
Pioneer Sand & Gravel Co	6000 West 5400 South Box 18457 Kearns, UT 84118	Pits and plant	Salt Lake.
Salt Lake Valley Sand & Gravel Co.[8]	800 North 1550 West Box E Sandy, UT 84070	____do	Do.
Savage Rock Products	748 West 300 South Salt Lake City, UT 84104	Pits and plants	Davis and Salt Lake.
Silver:			
Hecla Mining Co., Escalante Unit.[9]	Box 308 Enterprise, UT 84725	Underground mine, mill, plant.	Iron.
Stone:			
Crushed:			
Cedarstrom Calcite & Clay Corp	145 East 5th North Lehi, UT 84045	Quarry	Utah.
Diversified Marketing Services Inc.	Box 1181 Fillmore, UT 84631	Quarry and plant	Millard.
Lava Products Inc	94 West Tabernacle St. George, UT 84770	____do	Washington.
Lone Pine Quarries Co	Route 1, Box 120-01 Oakley, ID 83346	Quarries	Box Elder.
Lost Dutchman Construction Co.	Box 718 Lakeside, UT 84074	Quarry	Do.
McFarland & Hullinger	Box 238 Tooele, UT 84074	Quarries	Tooele.
Savage Rock Products	Box 11537 Salt Lake City, UT 84147	____do	Salt Lake.
Southern Pacific Transportation Co.	One Market Pl. San Francisco, CA 94105	Quarry	Box Elder.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Uranium-Vanadium:			
Atlas Corp., Atlas Minerals Div.	Box 1207 Moab, UT 84532	Underground mines and mill	Emery, Grand, San Juan.
Umetco Minerals Corp	Box 669 Blanding, UT 84511	Underground mines, mill, ore-buying station, research laboratory.	Emery, Garfield, San Juan.

[1]Also stone.
[2]Also clays.
[3]Also gold, molybdenum, and silver.
[4]Also silver.
[5]Also magnesium compounds, salt, and sodium sulfate.
[6]Also magnesium compounds.
[7]Also salt.
[8]Also industrial sand.
[9]Also gold.

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The Mineral Industry of Vermont

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Office of the State Geologist, Agency of Environmental Conservation, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Charles A. Ratté[2]

The value of nonfuel mineral production in 1987 was $72.4 million, a $17.2 million increase over that of 1986. The increased value was attributed primarily to greater demand for sand and gravel and stone used in highway construction, and increased demand for specific types of stone for building construction. In 1987, highway contracts in the State increased to $55.3 million from $36.9 million in 1986. The value of construction contracts of residential and nonresidential units also remained relatively strong in 1987. Nationally, the State ranked second in asbestos and talc production and third in the quantity of dimension stone produced.

Table 1.—Nonfuel mineral production in Vermont[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	W	NA	W	NA	$10
Sand and gravel (construction) thousand short tons	e2,700	e$7,000	4,834	$11,226	e4,700	e10,800
Stone:						
Crushed do.	1,689	7,468	e1,600	e7,600	2,159	20,400
Dimension do.	116	26,346	e105	e27,075	104	30,074
Combined value of asbestos, stone (crushed granite, 1987), talc, and values indicated by symbol W	XX	9,040	XX	9,310	XX	11,160
Total	XX	49,854	XX	55,211	XX	72,444

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Vermont in 1986, by county[1]

County	Minerals produced in order of value
Addison	Sand and gravel (construction).
Bennington	Do.
Caledonia	Do.
Chittenden	Do.
Essex	Do.
Franklin	Do.
Lamoille	Do.
Orange	Do.
Orleans	Asbestos, sand and gravel (construction).
Rutland	Sand and gravel (construction).
Washington	Do.
Windham	Talc, sand and gravel (construction).
Windsor	Do.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—Act No. 67 (H. 339), which became effective in July, provided for the designation of certain river segments as Outstanding Resource Waters. The most controversial section of the new law addressed gravel removal from streams. The law prohibited gravel removal from a watercourse if the gravel was for construction or sale. However, a riparian owner who has certain use rights on a stream may without a permit remove up to 50 cubic yards of gravel per year above the water line for personal use on his or her own property.

Acid rain and toxic waste disposal were critical environmental concerns in the State. In the case of acid rain, Vermont filed a fifth lawsuit against the Environmental Protection Agency (EPA), charging that the Federal Government failed to act on a State plan to reduce the impact of acid rain pollution. The lawsuit centered on a State effort to reduce acid rain by linking it to air pollution that reduces visibility at the Lye Brooke wilderness area near Manchester. Under Federal law, States are required to draft a State implementation plan to improve visibility in Federal wilderness areas. The Vermont plan, submitted to the EPA in 1986, argued that in order to clean up the air at Lye Brooke, the EPA must first act to reduce the air pollution from midwestern coal plants, the source of the poor visibility.

In 1987, more than 80 hazardous waste sites containing toxic chemicals in Vermont were awaiting cleanup. Two of the sites were on the list of places eligible for Federal Superfund money and six other sites were proposed for the Federal program.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Asbestos.—Vermont Asbestos Group Inc., one of two active asbestos companies in the United States, operated two open pit mines and a dry-processing mill near Lowell, Orleans County. The Lowell Mine and mill operated only intermittently during the year; 70 miners worked one 8-hour shift only 6 months of the year. This is in contrast to 1975 when 200 miners worked three 8-hour shifts year-round. The company produced 15 different asbestos fiber products for manufacturing clutches, brake components, and diaphragms for chlorine production. Because most foreign countries have not banned the use of asbestos products, about one-half of the asbestos produced was exported, primarily to countries in South America and the Far East.

Shipments of asbestos declined in 1987, the result of continuing adverse publicity on asbestos-related health risks and a proposed EPA ban phaseout of certain asbestos-containing products. In addition, the Office of Safety and Health Administration (OSHA) extended through July 21, 1988, an administrative stay on its 1986 regulation governing worker exposure to the nonasbestiform varieties of tremolite, anthophyllite, and actinolite. During the stay, OSHA continued to analyze the impact of using the asbestos standard to regulate the nonasbestiform varieties of the minerals.[3]

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only. This chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Based on these estimates, output and value of construction sand and gravel decreased 3% and 4%, respectively. Approximately 60 companies mined construction sand and gravel from 79 operations in all the State's counties. Leading counties in descending order of output were Chittenden, Rutland, Lamoille, and Bennington. Main uses were for road base and coverings,

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concrete aggregate, and fill.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only. This chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—Although production increased nearly 35% in 1987, value rose 168% over that of 1986. The anomolous rise in value was the result of reported marble production by Pleuss-Staufer Inc.'s Verpol plant in Rutland County, which had a much higher unit price value than most of the other companies that produced crushed stone. Prior to 1987, the company had not reported production from the Verpol plant.

Limestone was the primary rock quarried in the State, followed by granite and marble. Major uses were for bituminous concrete, fill, and road base aggregate.

Table 3.—Vermont: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse and fine aggregates: Other construction[2]	494	876
Other unspecified[3]	1,665	19,525
Total	2,159	[4]20,400

[1]Includes limestone and marble; excludes granite to avoid disclosing company proprietary data.
[2]Includes graded road base or subbase.
[3]Includes other fillers or extenders, production reported without a breakdown by end use, and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

Dimension.—Dimension stone, the State's leading mineral commodity in terms of value, was produced by 14 companies at 19 operations. Nationally, the State ranked third in output but first in value. Types of rocks quarried, in descending order of output, were granite, slate, and marble.

In May, a new 3-year contract covering 1,100 central Vermont granite workers was ratified, averting a possible strike. The contract covers union members of the Barre Granite Cutters, the Granite Manufacturers Association, and the United Steel Workers of America. The workers were employed at quarries and fabricating plants in the so-called "Barre Belt" in the towns of Barre City, Barre Town, Montpelier, Northfield, South Ryegate, and Chelsea.

Talc.—Nationally, Vermont ranked second in talc production, up from third place in 1986. Three companies mined talc at five operations in the State. Both production and value of talc increased over 1986. Primary uses for the talc were as a filler-extender in cosmetics, building materials, and plastics.

Early in the year, Vermont Talc Co., a subsidiary of OMYA Inc., received the necessary environmental permits to begin operating a new talc mine in Troy. The company began groundbreaking work in early spring. By yearend, it was producing ore from the deposit to be shipped to the recently modified Johnson talc mill about 25 miles from Troy. Vermont Talc had been shipping ore from its mines in Windham, approximately 140-miles from the Johnson mill.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]State geologist, Agency of Environmental Conservation, Waterbury, VT.
[3]Federal Register. Occupational Safety and Health Administration. Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. V. 52, No. 83, Apr. 30, 1987, pp. 15722-15723.

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Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Vermont Asbestos Group Inc	Box 54B Morrisville, VT 05661	Pit	Orleans.
Sand and gravel (construction):			
Ormond Bushey & Sons Inc	Box 183 Fairfax, VT 05454	Pits	Chittenden and Franklin.
Calkins Sand & Gravel Inc	Box 82 Lyndonville, VT 05851	Pits and plant	Caledonia and Orleans.
Joseph P. Carrara & Sons Inc	Route 116 Middlebury, VT 05753	Pits	Addison and Rutland.
William E. Daily Inc	Route 1, Box 51 Shaftsbury, VT 05262	____do	Bonnington.
Hinesburg Sand & Gravel Co	Box 200 Hinesburg, VT 05461	____do	Chittenden.
Frank W. Whitcomb Construction Corp	Box 429 Bellows Falls, VT 05101	Pit and plant	Rutland.
Stone:			
Crushed:			
Cooley Asphalt Paving Corp	Box 542 Barre, VT 05641	Quarry	Washington.
Pike Industries Inc	Route 3, Box 91 Tilton, NH 03276	____do	Caledonia.
Frank W. Whitcomb Construction Corp.	Box 29 Bellows Falls, VT 05101	Quarries	Chittenden.
White Pigment Corp	Florence, VT 05744	____do	Addison and Rutland.
Dimension:			
OMYA Inc	61 Main St. Proctor, VT 05765	Quarry and plant.	Rutland and Windsor.
Rock of Ages Corp., a subsidiary of John Swenson Granite Co. Inc.	Box 482 Barre, VT 05641	Quarries	Washington and Windsor.
John Swenson Granite Co. Inc	North State St. Concord, NH 03301	Quarry	Washington.
Talc:			
Vermont Talc Co., a subsidiary of OMYA Inc.	Route 11, Box 117 Chester, VT 05143	Mine and mill	Windham.
Windsor Minerals Inc	Box 680 Windsor, VT 05089	Mines and mills.	Windsor.

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The Mineral Industry of Virginia

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Palmer C. Sweet[2]

The value of nonfuel mineral production in Virginia in 1987 was about $461 million, surpassing $400 million for the first time in State history and increasing for the fifth consecutive year.

Crushed stone was again the dominant nonfuel mineral produced, accounting for about two-thirds of the State's total value. Each of the other 12 mineral commodities produced accounted for less than 10% of the total value. Two commodities—aplite and kyanite—were mined only in Virginia.

Strong demand from the construction industry boosted crushed stone output to 60.4 million short tons, the highest total reported in State history. Nationally, Virginia ranked fifth in crushed stone production.

Table 1.—Nonfuel mineral production in Virginia[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	814	$6,977	890	$7,700	[2]1,171	[2]$6,291
Gem stones	NA	[e]20	NA	20	NA	20
Iron oxide pigments (crude) ---short tons	2,280	W	W	W	W	W
Lime ---------- thousand short tons	633	28,103	624	27,362	699	29,435
Sand and gravel (construction) ----do----	[e]10,200	[e]42,000	11,670	46,488	[e]12,100	[e]43,400
Stone:						
Crushed ----------do----	51,686	221,900	[e]52,000	[e]224,700	60,376	295,903
Dimension ----------do----	10	3,136	[e]10	[e]3,128	9	2,720
Combined value of aplite, cement, clays (fuller's earth, 1987), gypsum, kyanite, sand and gravel (industrial), talc (soapstone, 1985, 1987), vermiculite, and values indicated by symbol W ----------	XX	79,140	XX	83,639	XX	83,673
Total ----------	XX	381,276	XX	393,037	XX	461,442

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Virginia in 1986, by county[1]

County	Minerals produced in order of value
Accomack	Sand and gravel.
Amherst	Clays, sand and gravel.
Augusta	Sand and gravel.
Bedford	Do.
Botetourt	Cement, clays.
Buckingham	Kyanite.
Campbell	Sand and gravel.
Caroline	Do.
Charles City	Do.
CHarlotte	Do.
Chesapeake (city)	Do.
Chesterfield	Sand and gravel, clays.
Craig	Sand and gravel.
Frederick	Sand and gravel, lime.
Giles	Lime.
Gloucester	Sand and gravel.
Grayson	Do.
Hanover	Aplite, sand and gravel.
Henrico	Sand and gravel.
Henry	Do.
James City	Do.
King and Queen	Clays, sand and gravel.
King George	Sand and gravel.
King William	Do.
Lancaster	Do.
Louisa	Vermiculite.
Middlesex	Sand and gravel.
Montgomery	Clays.
Northhampton	Sand and gravel.
Northumberland	Do.
Orange	Clays.
Pittsylvania	Sand and gravel.
Prince George	Do.
Prince William	Clays.
Pulaski	Iron oxide pigments.
Roanoke	Clays.
Rockbridge	Do.
Rockingham	Sand and gravel.
Shenandoah	Lime.
Smyth	Gypsum, clays.
Southhampton	Sand and gravel.
Spotsylvania	Do.
Stafford	Do.
Suffolk (city)	Do.
Sussex	Do.
Tazewell	Clays.
Virginia Beach (city)	Sand and gravel.
Warren	Cement.
Westmoreland	Sand and gravel.
Wythe	Iron oxide pigments.
Undistributed[2]	Clays, stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—Virginia's mineral value, because of the domination of crushed stone in relation to total mineral value, typically fluctuated in response to demand from the construction industry. Since 1982, output of crushed stone increased by 73%, from 35 million short tons to 60.4 million tons in 1987. During that period, the Virginia economy expanded and the construction industry benefited from lower interest rates. Also in 1987, Virginia began the largest highway construction and repair program in the State's history, a 6-year, $475 million per year program. Housing starts, another indicator of expanding construction activity and demand for mineral aggregate, also increased significantly during the 1983-87 period, averaging about 65,000 new units each year. Crushed stone output averaged 52.8 million tons annually. In contrast, from 1980 through 1982, new housing units averaged 33,000 per year and stone production, 36.8 million tons.

Mining and mineral-related industries in Virginia reported production valued at about $2 billion in 1987. Output of mineral commodities processed or manufactured in the State and surveyed by the Bureau of Mines included calcined gypsum, finished iron oxide pigments, expanded perlite, recovered elemental sulfur, and exfoliated vermiculite valued at $26.4 million. Production of the fuel and energy commodities of coal, oil, and gas generated about $1.5

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billion in value with coal accounting for 97% of the total. Virginia's production of 45.5 million short tons of coal ranked the State seventh nationally.

Legislation and Government Programs.—The Virginia Marine Resources Commission (VMRC) issued "Guidelines for Mineral Activities on State-Owned Submerged Lands" pursuant to Section 62.1-4 of the Code of Virginia. The VMRC was responsible for reviewing proposals for mineral leasing and mining activities on all State-owned submerged lands, comprising 2,300 square miles of water surface covering 1.5 million acres. The Virginia Department of Mines, Minerals, and Energy is the mining regulatory authority.

The Virginia Division of Mineral Resources (VDMR), Department of Mines, Minerals, and Energy, summarized a 30-year clay sampling and evaluation program, a joint effort by VDMR and the U.S. Bureau of Mines.[3] The report identified locations and potential uses from 630 samples of clay, shale, and related materials in Virginia. Studies continued on metallic mineralization, tantalum and niobium resources, carbonate resources and precious metal prospects and occurrences.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Crushed stone accounted for about $296 million or 64% of Virginia's value of nonfuel mineral production. Approximately 18% or $82.5 million of the State's nonfuel mineral value was from production of common clays, crude iron oxide pigments, lime, construction sand and gravel, and dimension stone; the quantity and value of production for these commodities are given in table 1.

The remaining 18% of Virginia's nonfuel mineral value was derived from output of aplite, portland and masonry cement, fuller's earth, crude gypsum, kyanite, industrial sand, talc, and vermiculite. The quantity and value for these commodities are withheld from publication to avoid disclosing company proprietary data. For the most part, each of these commodities was produced by only one company in Virginia. Aplite and kyanite were each mined by only one company in the United States and vermiculite in only three States by three companies.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

The value of crushed stone production in Virginia during the past decade has increased from about one-half to two-thirds of the State's total value of nonfuel mineral production. The increased price of crushed stone has accounted for most of the increase in value. In 1977, about 42 million short tons of stone at an average price of $2.63 per ton (f.o.b. quarry) was produced; by 1987, the price had risen to $4.90 per ton. The 1987 production of 60.4 million tons at 1977 prices of $2.63 per ton would equate to a value of $159 million versus the 1987 value of nearly $296 million.

Along with higher prices, the strong demand for stone produced in Virginia resulted in the opening and expansion of numerous quarries throughout the State. Strong demand from the construction industry in the Roanoke area resulted in three companies initiating procedures to open quarries in Botetourt County. Luck Stone Corp., one of the State's leading stone producers, expected to open a $10 million traprock quarry operation in Bealeton early in 1988. The company had received permission to open the quarry in April, but opposition by community residents delayed the startup. Crushed stone from the quarry, which is within 45 miles of the Metropolitan Washington, DC, market, was to be sold for use in road construction, septic tank fields, and concrete block and pipe. General Crushed Stone Co. received approval to open a new quarry on a 293-acre site in Hanover County. The new operation was required to maintain a 385-foot buffer zone and to correct any water well problems within 2,000 feet of the quarry. Also during the year, Vulcan Materials Co., which operated nine quarries in Virginia, purchased Sanders Quarry Inc. near Warrenton. Vulcan purchased the operation on a 360-acre site because of strong demand from the Northern Virginia market and extensive reserves estimated at 260 million tons.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in three Virginia districts depicted in figure 1.

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Table 3.—Virginia: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Macadam	271	579
Riprap and jetty stone	926	8,590
Filter stone	479	2,275
Coarse aggregate, graded:		
Concrete aggregate, coarse	8,250	41,691
Bituminous aggregate, coarse	4,027	22,928
Bituminous surface-treatment aggregate	1,485	7,482
Railroad ballast	906	3,684
Fine aggregate (-3/8 inch):		
Stone sand, concrete	951	4,687
Stone sand, bituminous mix or seal	1,270	6,039
Screening, undesignated	1,780	7,961
Coarse and fine aggregates:		
Graded road base or subbase	15,811	70,512
Unpaved road surfacing	954	4,997
Crusher run or fill or waste	4,557	17,621
Other construction[2]	3,387	17,121
Agricultural:		
Agricultural limestone	633	5,743
Poultry grit and mineral food	100	W
Chemical and metallurgical: Cement manufacture	1,114	6,798
Special:		
Mine dusting and acid-water treatment	216	1,450
Other fillers or extenders	41	313
Other miscellaneous[3]	1,010	9,144
Other unspecified[4]	12,208	56,286
Total	60,376	[5]295,903

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes granite, limestone, traprock, dolomite, marble, sandstone, quartzite, slate, and miscellaneous stone.
[2]Includes fine aggregate, combined coarse and fine aggregates, and terrazzo and exposed aggregate.
[3]Includes agricultural uses, lime manufacture, and glass manufacture, flux stone, sulfur oxide removal, asphalt fillers or extenders, and data indicated by symbol W.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.

Table 4.—Virginia: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	728	2,539	240	1,257	709	7,647
Coarse aggregate, graded[2]	2,741	11,481	2,533	13,012	9,395	51,292
Fine aggregate (-3/8 inch)[3]	2,111	9,193	461	2,470	2,125	10,821
Coarse and fine aggregates[4]	4,836	17,724	3,511	14,904	13,621	63,588
Other construction	399	1,533	301	958	1,345	7,750
Agricultural[5]	567	5,714	W	W	W	W
Chemical and metallurgical[6]	(7)	(7)	--	--	W	W
Special[8]	308	2,049	--	--	--	--
Other miscellaneous	2,034	14,430	--	--	--	--
Other unspecified[9]	4,108	20,119	1,313	6,064	6,991	31,359
Total[10]	17,833	84,871	8,359	38,665	34,184	172,457

W Withheld to avoid disclosing company proprietary data; included with "Other unspecified."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screening, undesignated).
[4]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, crusher run or fill or waste, and combined coarse and fine aggregates.
[5]Includes agricultural limestone, poultry grit and mineral food, and other agricultural uses.
[6]Includes cement manufacture, lime manufacture, flux stone, glass manufacture, and sulfur oxide removal.
[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[8]Includes mine dusting, asphalt filler, and other fillers or extenders.
[9]Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.
[10]Data may not add to totals shown because of independent rounding.

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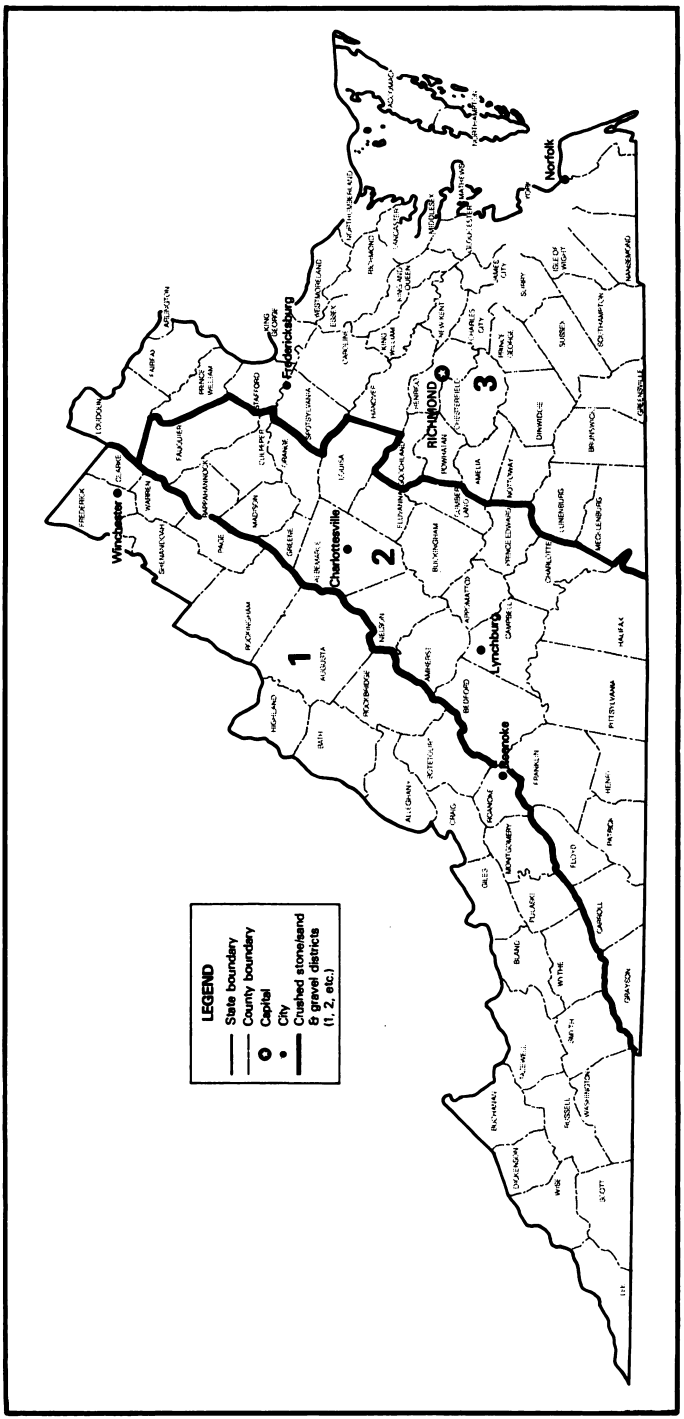

Figure 1.—Aggregate-producing districts in Virginia.

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METALS

No metals were mined in Virginia. One company produced a small quantity of iron oxide pigments in Pulaski County. The finished product was used as a coloring agent in a variety of products. Two minimills also were operated in the State; one in Roanoke, the other in Norfolk.

[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.
[2]Head geologist, Economic Geology Section, Virginia Division of Mineral Resources.
[3]Sweet, P. C. Clay Material Testing Program, 1957-1986. VA Div. Min. Res., Pub. 76, 1988, 46 pp.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County or city
Aplite:			
The Feldspar Corp	Route 1, Box 305 Montpelier, VA 23192	Quarry and plant	Hanover.
Cement:			
Lone Star Cement Inc.[1]	Box 27 Cloverdale, VA 24077	----do------	Botetourt.
Lone Star Lafarge Inc	Box 5128 Chesapeake, VA 23320	Plant	Chesapeake (city).
Riverton Corp.[2]	Box 4004 Front Royal, VA 22630	Quarry and plant	Warren.
Clays:			
Brick & Tile Corp	Box 45 Lawrenceville, VA 23868	Pits and plant	Brunswick and Greensville.
General Shale Products Corp	Box 3547 Johnson City, TN 37601	----do------	Rockbridge and Smyth.
Old Virginia Brick Co. Inc	Box 506 Salem, VA 24153	Pit and plant	Montgomery and Roanoke.
Webster Brick Co. Inc	Box 12887 Roanoke, VA 24029	----do------	Botetourt and Orange.
Gypsum:			
USG Corp	Box 4686 Norfolk, VA 23523	Plant	Norfolk (city).
Do	Route 1 Saltville, VA 24370	Mine and plant	Smyth and Washington.
Iron oxide pigments (crude):			
Hoover Color Corp	Box 218 Hiwassee, VA 24347	----do------	Pulaski.
Kyanite:			
Kyanite Mining Corp	Dillwyn, VA 23936	Mines and plants Plant	Buckingham. Prince Edward.
Lime:			
Chemstone Corp	Route 629, Box 71 Strasburg, VA 22657	Quarry and plant	Shenandoah.
USG Industries Inc	Star Route 635 Ripplemead, VA 24150	Underground mine and plant.	Giles.
Sand and gravel:			
Fredericksburg Sand & Gravel Co	Box 650 Culpeper, VA 22701	Pit and plant	Stafford.
Solite Corp	Box 27211 Richmond, VA 23230	----do------	King George.
Tarmac-Lone Star Inc	Box 420 Norfolk, VA 23501	Pits and plants	Charles City, Chesterfield, Henrico, Prince George.
Williams Corp. of Virginia	Box 938 Norfolk, VA 23501	----do------	Virginia Beach (city).
Stone:			
W. W. Boxley Co	Box 13527 Roanoke, VA 24034	Quarries	Bland, Botetourt, Campbell, Henry, Richmond (city), Tazewell.
Luck Stone Corp	Box 29682 Richmond, VA 23229	----do------	Albemarle, Augusta, Fairfax, Goochland, Greene, Halifax, Loudoun, Nottoway, Rockingham.
Vulcan Materials Co., Midsouth Div	Box 7 Knoxville, TN 37901	----do------	Washington.
Vermiculite:			
Virginia Vermiculite Ltd	Box 70 Louisa, VA 23093	Mine and plant	Louisa.

[1]Also stone.
[2]Masonry cement only; also produces lime and limestone.

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The Mineral Industry of Washington

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Washington Division of Geology and Earth Resources for collecting information on all nonfuel minerals.

By W. L. Rice[1] and Nancy L. Joseph[2]

Washington's nonfuel mineral production value in 1987 rose to $438 million, an increase of about 16% from that of 1986. The production value of all of the State's major mineral commodities—gold, magnesium metal, construction sand and gravel, cement, and crushed stone—increased in 1987. The most important contributors to the overall increase were gold, crushed stone, and cement. Magnesium metal was the leading commodity in terms of value, followed by gold, construction sand and gravel, cement, and crushed stone. Industrial minerals—chiefly cement, clays, diatomite, lime, olivine, sand and gravel, and stone—accounted for nearly 55% of the State's total nonfuel mineral value for the year, compared with 56% in 1986, 89% in 1985, and 95% in 1984.

Washington ranked 21st in the Nation in the value of nonfuel minerals produced, identical to the ranking achieved in 1986.

Table 1.—Nonfuel mineral production in Washington[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry thousand short tons	W	W	6	$530	W	W
Portland do.	W	W	1,212	59,091	1,282	$63,600
Clays do.	243	$1,402	252	1,560	416	2,356
Gem stones	NA	e200	NA	200	NA	200
Peat thousand short tons	12	292	W	W	7	191
Sand and gravel:						
Construction do.	e22,700	e62,300	26,342	76,387	e25,300	e78,900
Industrial do.	322	5,589	W	W	294	5,186
Stone:						
Crushed do.	9,543	31,052	e9,000	e84,100	14,754	49,618
Dimension do.	1	53	e1	e69	(2)	42
Combined value of barite (1985), calcium chloride (natural), copper (1987), diatomite, gold, gypsum, lime, magnesium metal (1986-87), olivine, silver, and values indicated by symbol W	XX	120,719	XX	204,688	XX	238,269
Total	XX	221,607	XX	376,625	XX	438,362

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Less than 1/2 unit.

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Table 2.—Nonfuel minerals produced in Washington in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel.
Asotin	Do.
Benton	Do.
Chelan	Gold, sand and gravel, silver.
Clallam	Clays, sand and gravel.
Clark	Sand and gravel, clays.
Ferry	Gold, silver.
Franklin	Sand and gravel.
Grant	Diatomite, sand and gravel.
Grays Harbor	Sand and gravel, peat.
Island	Sand and gravel.
Jefferson	Do.
King	Cement, sand and gravel, clays, peat.
Kitsap	Sand and gravel.
Kittitas	Do.
Klickitat	Do.
Lewis	Do.
Lincoln	Do.
Mason	Do.
Okanogan	Sand and gravel, peat, gypsum.
Pacific	Sand and gravel.
Pend Oreille	Cement, sand and gravel.
Pierce	Sand and gravel, clays, lime.
San Juan	Sand and gravel.
Skagit	Olivine, sand and gravel.
Snohomish	Sand and gravel.
Spokane	Sand and gravel, clays.
Stevens	Sand and gravel, magnesium compounds, clays, lime.
Thurston	Sand and gravel.
Walla Walla	Do.
Whatcom	Cement, sand and gravel.
Whitman	Stone (crushed).
Yakima	Sand and gravel.
Undistributed[2]	Stone, gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—An upward progression in the value of Washington's gold production that commenced in 1985 continued through 1987. Increased production from the State's two major gold mines was supplemented by output from several smaller scale operations. Exploration and development of new gold deposits continued at an accelerated level during the year.

The State's aluminum industry achieved a partial recovery from the severe downturn experienced in 1985 and 1986. Improved international market conditions and consequent increased aluminum prices led to the sale and reopening of two reduction plants and to increased production at another. A conservation-modernization incentive program offered by the Bonneville Power Administration (BPA) was accepted by three companies operating smelters within the State.

Employment.—The State's mining-industry employment increased about 3% over that of 1986. According to the State of Washington Employment Security Department, mining and quarrying employment rose to about 3,000 from the 2,900 recorded in 1986.

As a result of partial recovery in the aluminum reduction sector of the State's primary metals industry, aluminum smelter employment rose to 7,400 by yearend, up from 6,600 in 1986.

Environmental Issues.—Controversy over possible long-term toxicity of smelter slag from the Tacoma copper smelter, closed permanently by ASARCO Incorporated in March 1985, remained unsolved. The slag was in widespread local use as fill for driveways and roads and in landscaping, breakwaters, and railroad ballast, and as ballast for the Hood Canal bridge. The U.S. Environmental Protection Agency contended that the slag contained significant amounts of lead and arsenic that could be harmful if bioavailable; the Tacoma-Pierce County Department of Health and the State's Department of Ecology maintained that no problem existed. Further testing for arsenic contamination was delayed for lack of funding. Closure of Asarco's Tacoma smelter had a positive effect on regional air quality, according to studies by scientists at the University of Washington and in British Columbia, Canada. Comparison of rainwater chemistry before and after the smelter closure disclosed a marked decrease in arsenic at most sampling locations. Data from the studies were being used to develop techniques for tracing air- and rainwater-borne chemicals to specific sources.

Exploration Activities.—The level of exploration in Washington, predominantly for metallic minerals, was up from that of 1986. According to the Washington Division of Geology and Earth Resources, a minimum of 55 companies and individuals explored for metals in 1987; 92% of them were seeking gold and silver deposits. Several companies also explored for copper, lead, molybdenum, platinum, uranium, and zinc. More than 2,500 new mining claims were filed in 1987, for a total of 14,817 claims filed since 1976.

Precious-metals exploration in Chelan County was confined primarily to the Wenatchee District, where Asamera Minerals Inc. explored on its properties and, in joint venture with Granges Gold Corp., investigated the potential of the old L. D. Golden King Mine area.

Ferry County was the most active area in the State for precious-metals exploration. More than 14 companies explored in the northwestern part of the county, and sever-

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al large-scale drilling efforts were conducted during the year. Echo Bay Mines Ltd. continued its exploration and a $2.5 million feasibility study at four deposits north of Republic, and Hecla Mining Co. continued drilling on its Republic District properties outside the Golden Promise Mine area. Asarco, Crown Resources Corp., Cyprus Gold Exploration Corp., Houston Oil and Minerals Inc., N. A. Degerstrom Inc., United States Borax & Chemical Corp., and others were active at various locations in the county.

In Okanogan County, Westmont Mining Inc. explored the Bodie gold property in the Toroda Creek graben; Kerr-McGee Corp. continued exploration on its Meyers Creek District property; Omak Minerals Ltd. drilled for gold, molybdenum and other minerals northwest of Omak; Newhawk Gold Mines Ltd. drilled at a gold-copper prospect south of Twisp; and Quintana Minerals Corp. explored gold properties marginal to its Mazama copper porphyry deposit. Several other companies also were active in the county during the year.

Elsewhere in the State, less intensive exploration for precious metals occurred in King, Pierce, Stevens, Whatcom, and Yakima Counties. Other companies explored for silver and base metals in Pend Oreille and Stevens Counties. Meridian Minerals Co. explored for clays, diatomite, limestone, marble, and crushed stone sources in several areas in the State.

Legislation and Government Programs.—In October, a special session of the Washington Legislature enacted a "Superfund" law that imposed a special tax on companies dealing with hazardous substances in the State. Tax proceeds, expected to amount to as much as $390 million over the next 10 years, would be used to finance the cleanup of sites polluted by unknown or insolvent parties. The law also included incentives designed to encourage company cleanup of hazardous waste.

In March, the BPA inaugurated a $76 million, 10-year, conservation and modernization program to aid the troubled Northwest aluminum industry. The program paid smelters one-half cent for every kilowatt hour of electricity saved from the amount needed to produce a pound of aluminum. At one smelter, the program resulted in the savings of 66 megawatts, or about 9% of the energy consumed by eight potlines. By year-end, three companies operating smelters in Washington had applied to modernize their operations.

Mineral leasing payments to the State by the U.S. Bureau of Land Management totaled about $262,000 in 1987.

Total revenue from prospecting, mining, and quarrying on State lands was $506,069 for the fiscal year ending June 30, 1987, up about 12% from 1986 as a result of increased revenues from mineral leases and contracts and from sand and gravel production. The increase was attributed in part to lifting of a moratorium on mining contracts and prospecting permits on State-managed lands. The moratorium was imposed by the Commissioner of Public Lands in April 1986 while awaiting new leasing legislation; that, with input from the mining community, was passed by the 1987 legislature. New applications for prospecting or mining on about 3.6 million acres of State lands were stalled by the moratorium.

The Mining and Mineral Resources and Research Institute of the University of Washington, Seattle, received an allotment of $138,000 from the U.S. Bureau of Mines in 1987. The institute has received a total of $1.34 million since inception of the program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Calcium Chloride.—Tahoma Chemical Co. Inc., in Steilacoom, and Occidental Chemical Corp. in Tacoma, Pierce County, manufactured synthetic calcium chloride using hydrochloric acid and limestone barged in from British Columbia, Canada.

Cement.—A generally expanding economy in the Puget Sound region, with consequent increases in private sector and public works construction, resulted in a rise in the consumption and production of cement in 1987. Portland cement production rose by nearly 6% in volume and almost 8% in value from the totals recorded in 1986. Portland cement was produced by four companies in King, Pend Oreille, and Whatcom Counties: Ideal Basic Industries Inc. and Ash Grove Cement West Inc., Seattle; Lehigh Portland Cement Co., Metaline Falls; and Tilbury Cement Co., Bellingham. Ash Grove, Lehigh, and Tilbury also produced masonry cement.

Tilbury Cement of Delta, British Columbia, Canada, purchased the Columbia

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Northwest Corp. cement plant in Bellingham in September. Prior to the sale, the plant produced cement; subsequently, it ground clinker imported from British Columbia. All Puget Sound cement plants used limestone imported from British Columbia; Lehigh was the sole Washington plant that used limestone mined in-State.

The bulk of Washington's cement production was general use, moderate heat Types I and II gray portland cement; lesser amounts of high early strength Type II, high sulfate resistant Type V, oil well, and pozzolanic cements also were produced. Portland cement was used by ready-mixed concrete companies (77%), concrete products manufacturers (9%), other contractors (4%), miscellaneous customers (4%), building material dealers (3%), and highway contractors and government agencies (3%). Finished portland cement was shipped from plants to terminals by rail (67%), barge (21%), and truck (12%); shipments from plants and terminals to customers were by truck (75%), and by rail and other means (25%).

Clays.—Clay production in 1987 increased nearly 65% in quantity and 51% in value from 1986. Clay was produced by six companies from 13 deposits in six counties. Nearly 86% of the State's clay production came from Clallam and King Counties; fire clay was produced from three pits in King and Stevens Counties. About 99% of the clay production was used for common brick, face brick, or in portland cement; the remainder was consumed in flue linings, structural tile, and fire brick manufacture.

Interpace Industries Inc. secured $650,000 in State-backed bond financing to expand the Mica brick plant in Spokane County. The funds were earmarked for additional brick drying capacity that would allow the company to increase annual production by 7 million brick.

Diatomite.—Washington's 1987 diatomite production decreased slightly in quantity and value from 1986. Witco Chemical Corp.'s Inorganic Specialties Div., the State's only producer, mined diatomite from two pits and processed the material in a plant at Quincy, Grant County.

Gypsum.—Crude gypsum production in the State decreased in quantity but increased in value from that of 1986. Crude gypsum was mined by Agro Minerals Inc. from Washington's only gypsum mine, near Tonasket, Okanogan County. Agro Minerals has been mining gypsite from small saline lake bottoms since 1948; the dried and sized gypsum product was used as a soil conditioner. Norwest Gypsum Co. of Seattle was purchased for $70 million in September, by James Hardie Industries (U.S.A.) Inc. The purchased operation, renamed James Hardie Gypsum, and Domtar Gypsum America Inc., Tacoma, Pierce County, produced calcined gypsum in 1987.

Lime.—The State's 1987 lime production and value were unchanged from 1986. Quicklime was produced by Northwest Alloys Inc., near Addy, Stevens County, while Continental Lime Inc. produced quicklime and hydrated lime at its Tacoma plant.

Olivine.—Olivine production reported from the State increased nearly 47% in quantity and by nearly 96% in value from 1986. Applied Industrial Material Corp. (AIMCOR) produced olivine from stockpiled ore at the Twin Sisters Mine, Skagit County, and Olivine Corp. mined and milled olivine from the Sven Larson quarry, Whatcom County.

Peat.—Both quantity and value of Washington peat production decreased substantially from that of 1986; however, its unit price increased. Four companies reported production of sold-in-bulk peat: Sol Chrystel, Grays Harbor County; Maple Valley Humus, King County; Bonaparte Peat, Okanogan County; and Keith L. Asbury, Kitsap County.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987, and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Estimated 1987 construction sand and gravel production decreased by about 4% in quantity but increased by 3% in value from 1986. A combination of city, county, State, and Federal Government projects and an expanding private sector construction industry kept demand for aggregate up in the greater Puget Sound region. Two Government-funded projects scheduled to continue through 1988 were the $400 million Metro tunnel linking the Mount Baker tunnel with the Evergreen floating bridge on Lake Washington, and the $1.25 billion extension of Interstate 90 from Interstate 5 in Seattle east to Issaquah.

Industrial.—Industrial sand and gravel production increased in both quantity and value. Production was reported from three

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operations in Chelan, King, and Stevens Counties; primary uses were for glass containers and flat glass, fiberglass, sandblasting, cement manufacture, chemicals, and traction sand.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—The quantity of crushed stone production in Washington in 1987 increased by nearly 55%, and the value rose by almost 60% over that of 1985.

Columbia River Carbonates produced ground white calcium carbonate at the Woodland plant, Clark County; the company did not operate its quarry at Wauconda, Okanogan County, in 1987. Pacific Calcium Inc. mined and milled limestone and dolomite at its property near Tonasket, Okanogan County.

Northwest Alloys quarried magnesian dolomite near Addy, Stevens County, for use in its magnesium metal roduction plant. Nanome Aggregates Inc. produced dolomite for terrazzo chips, decorative stone, and fillers from several Stevens County quarries. Allied Minerals Inc., Chewelah Eagle Mining Co., and Northwest Marble Products Co. mined dolomitic limestone, marble, and white dolomite, respectively, from quarries in Stevens County.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 4 presents end-use data for crushed stone produced in the three Washington districts depicted in figure 1.

Table 3.—Washington: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	729	3,797
Coarse aggregate, graded:		
Concrete aggregate, coarse	515	2,047
Bituminous aggregate, coarse	344	831
Bituminous surface-treatment aggregate	212	916
Railroad ballast	214	1,022
Fine aggregate (-3/8 inch):		
Stone sand, concrete	184	782
Stone sand, bituminous mix or seal	125	494
Screening, undesignated	106	218
Coarse and fine aggregates:		
Graded road base or subbase	4,056	12,168
Unpaved road surfacing	569	1,902
Terrazzo and exposed aggregate	136	679
Crusher run or fill or waste	320	1,294
Other construction[2]	87	331
Agricultural: Agricultural limestone	7	32
Chemical and metallurgical: Cement manufacture	15	120
Special: Other miscellaneous[3]	49	723
Other unspecified[4]	7,085	22,260
Total[5]	14,754	49,618

[1]Includes traprock, sandstone, limestone, granite, dolomite, volcanic cinder and scoria, quartzite, and miscellaneous stone.
[2]Includes macadam and filter stone.
[3]Includes flux stone, whiting or whiting substitute, and other fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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Table 4.—Washington:[1] Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[2]	366	1,928	--	--	7	23
Coarse aggregate, graded[3]	842	2,997	W	W	W	W
Fine aggregate (-3/8 inch)[4]	246	770	W	W	W	W
Coarse and fine aggregates[5]	2,593	7,151	772	2,461	970	2,697
Other construction	10	15	417	1,806	138	446
Agricultural[6]	--	--	(7)	(7)	(7)	(7)
Chemical and metallurgical[8]	--	--	--	--	(7)	(7)
Special[9]	--	--	(7)	(7)	(7)	(7)
Other miscellaneous	27	261	11	389	32	226
Other unspecified[10]	3,945	12,172	100	476	1,308	3,980
Total[11]	8,029	25,293	1,299	5,132	2,455	7,372

W Withheld to avoid disclosing company proprietary data; included with "Other construction."

[1]Includes 2,970,178 short tons valued at $11,820,940 not reported by county.

[2]Includes macadam, riprap and jetty stone, and filter stone.

[3]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.

[4]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screen).

[5]Includes graded road base or subbase, unpaved road surfacing, terrazzo and exposed aggregate, and crusher run or fill.

[6]Includes agricultural limestone.

[7]Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[8]Includes cement manufacture and flux stone.

[9]Includes whiting or whiting substitute and other fillers or extenders.

[10]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[11]Data may not add to totals shown because of independent rounding.

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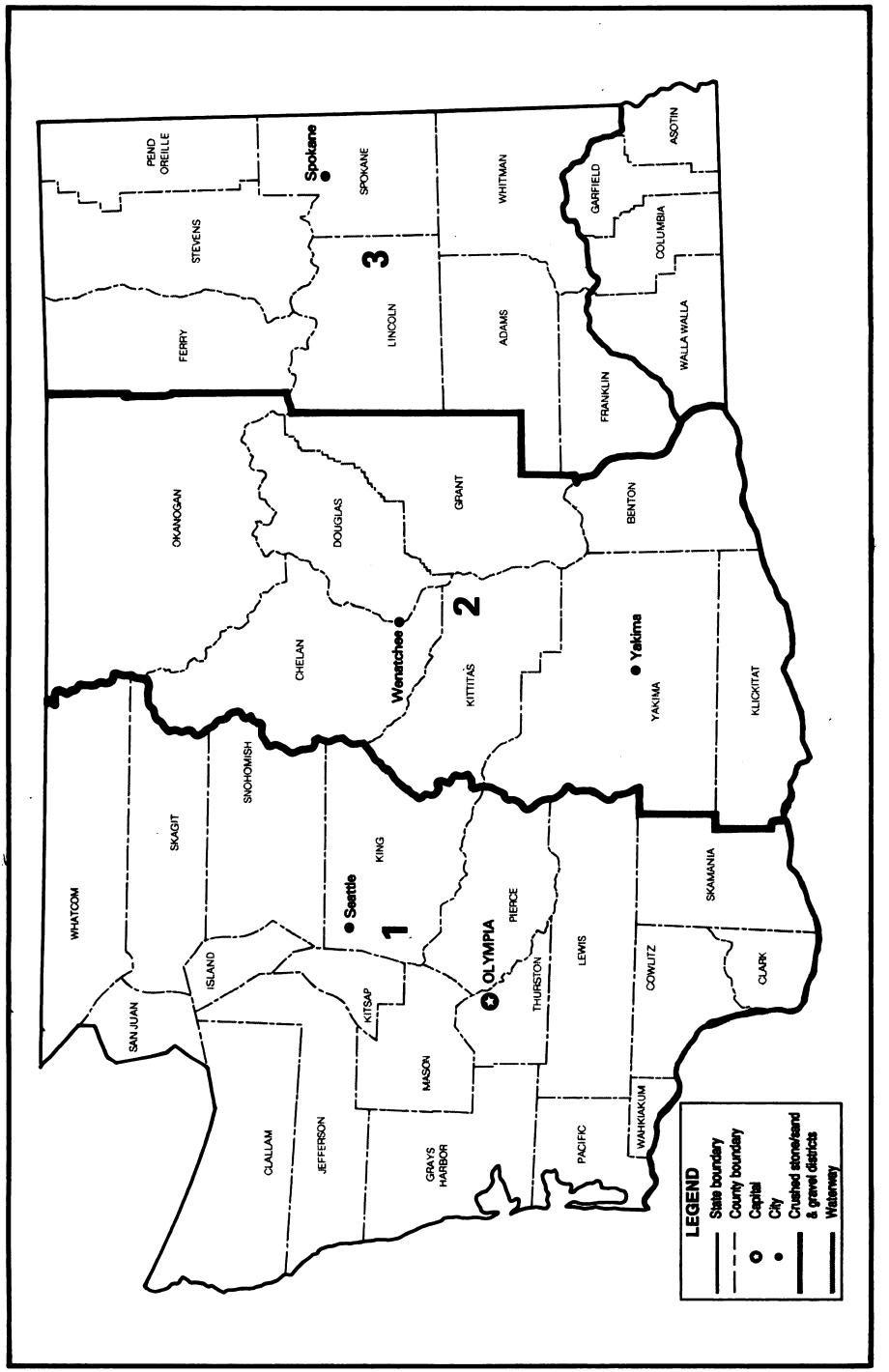

Figure 1.—Aggregate-producing districts in Washington.

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Dimension.—Dimension stone was produced by three companies from four quarries in Skagit and Yakima Counties.

Sulfur (Recovered).—The State's sulfur production, a secondary process of Puget Sound petroleum refining, increased by about 14% in quantity but decreased by about 8% in value from 1986.

Sulfur production was reported by Texaco Inc. from its Skagit County refinery, and by Atlantic Richfield Co. and Mobil Oil Corp. from refining operations at Cherry Point and Ferndale, Whatcom County.

METALS

Aluminum.—Aluminum production in Washington increased by 4% in volume and decreased 7% in value; the State retained its first place ranking nationally and was credited with nearly 28% of total domestic aluminum output in 1987. After a slow start, Washington's depressed aluminum industry responded to a marked easing of the worldwide aluminum oversupply and began to revive by midyear. The State's seven aluminum smelters, which operated at about 83% of total rated annual ingot capacity in January, finished the year operating at nearly 90% of the total rated annual capacity of 1,324,000 short tons of aluminum ingot. Prices for the metal started the year at about 53 cents per pound, advanced to approximately 74 cents per pound in early June, and rose to nearly 88 cents per pound by yearend.

Commonwealth Aluminum Co. closed its 185,000-ton-per-year-capacity smelter near Goldendale, Klickitat County, in mid-January. In early August, the operation was sold to Columbia Aluminum Corp., which restarted the plant in late August as a tolling facility for foreign alumina. Columbia Aluminum finished the year operating at two-thirds of annual rated capacity.

The Aluminum Co. of America (Alcoa) smelter at Vancouver, Clark County, which closed following a midyear strike in 1986, was sold on June 1 to Vanalco Inc. The idled 121,000-ton-per-year plant was restarted in late July at reduced capacity, and was operating at 60% of capacity by yearend. Full-scale production was to resume sometime in 1988.

Kaiser Aluminum & Chemical Corp. began the year operating the Mead smelter, Spokane County, at about 63% of its 220,000-ton-per-year rated capacity; by the fourth quarter 1987, production was increased to nearly 88% of capacity.

Arsenic.—Asarco shipped byproduct arsenic trioxide and arsenic metal from stock at its closed Tacoma copper smelter. The smelter, which closed permanently in 1985, had been the only domestic processor of high-arsenic copper concentrate.

Gold and Silver.—Washington's gold production, reported from four lode mines in Chelan, Ferry, and King Counties, increased by 26% in quantity and by nearly 54% in value from 1986. Silver, as a byproduct from gold recovery, was reported from three lode mines. Production increased by 65% in quantity and more than doubled in value from 1986. Copper production was reported in the State for the first time since 1982; it was a minor byproduct of gold recovery at two lode mines.

The Asamera Minerals (U.S.) Inc.-Breakwater Resources Ltd. Cannon Mine, at Wenatchee, Chelan County, again ranked first in gold production in the State, and gained the 11th rank nationally in 1987. The first year of uninterrupted full-scale production was achieved in 1987. According to an Asamera news release, the 1,500-ton-per-day-capacity underground mine produced 137,800 troy ounces of gold and 188,400 troy ounces of silver from 487,065 short tons of ore during the year. Average millhead grade was 0.31 ounce of gold and 0.49 ounce of silver per ton; the mill recovery rate averaged 91.6% for gold and 89.8% for silver. Asamera did approximately 12,000 feet of surface drilling along the trend of old mine workings at the Lovitt Mine, which adjoins the Cannon property to the south. Late in the year, the company entered into a joint venture with Granges Gold Corp. to undertake a 5,000-foot underground drilling program from the 1250 level of the Lovitt Mine. Surface drilling on Asamera-controlled lands in the southern portions of the Wenatchee District revealed a large silicified and mineralized zone bearing significant gold values. Asamera planned to drive a 6,000-foot tunnel to permit underground drilling of the zone.

Hecla Mining Co.'s Republic Unit Mine (Knob Hill) at Republic, Ferry County, again was Washington's second-ranked gold producer. The company's annual report cited a record-high output of 70,095 ounces of gold and 341,272 ounces of silver from 72,491 tons of ore in 1987. Recovered ore grade was up 43% to 0.97 ounce of gold per ton, compared with 0.68 ounce per ton in 1986. The 76% increase in gold production and the more-than-doubled silver output were attributed to higher metal grades as mining crews moved into the high-grade Golden Promise area, and to accelerated

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mining and milling rates. The 1,300-foot-deep, $2.2 million Golden Promise shaft was dedicated in January; exploration, development, and mining continued on the Golden Promise vein system throughout the year. Capital improvements in 1987 included installation of a mine-backfill storage and delivery system and upgrading of the mine pumping system. Proven and probable ore reserves increased from 372,000 tons at 1 ounce of gold per ton in 1986, to 515,000 tons grading 0.80 ounce per ton in 1987.

Vulcan Mountain Inc. operated the Gold Dike open pit near Curlew, Ferry County; average grade of the ore leached was 0.10 ounce of gold and 0.15 ounce of silver per ton. Vulcan also produced from the adjoining Gold Hill property owned by Sundance Mining-Development Inc. In December, Sundance negotiated a lease agreement with U.S. Borax, which had previously secured an option to purchase Vulcan's property. U.S. Borax initiated a drilling program in October to better define dimensions of the ore-bearing zone and to increase reserves.

High County Mining & Exploration Co. mined on the 200 and 300 levels of the Valley Mine north of Republic; the vein structure averaged 8 feet in width and graded 0.2 ounce of gold per ton. High County entered a joint venture with Curlew Lake Resources Inc. to increase financing for new exploration and to increase mill capacity from 72 tons to 120 tons per day.

Chemgold Inc.-Crown Resources reportedly mined 30,000 tons of ore grading 0.03 ounce of gold per ton at the South Penn deposit, Ferry County. The gold was to be recovered by heap leaching.

CSS Management Corp. reported gold production from the Damon Hill Mine near Skykomish, King County; the ore was milled at the company's recovery plant at Baring.

The Echo Bay Mines Ltd.-Crown Resources joint venture conducted detailed exploration at four Ferry County gold properties. In October, a contractor began sinking a 3,000-foot-long, 400-foot-deep decline into the Kettle River property; a drilling program from the decline would explore two previously discovered veins. Plans called for an underground mine at the Kettle site; a feasibility study started in 1987 was scheduled for completion in 1988. Echo Bay also explored at the Key West, Key East, and Overlook properties; open pits were planned for the Key sites, and a combination open pit-underground operation was envisioned for the Overlook deposit. Drill-indicated open pit reserves at the three properties amounted to 3.5 million tons grading 0.127 ounce of gold per ton. Drill-indicated underground reserves of 477,000 tons of 0.247 ounce gold per ton material were outlined at the Overlook and Kettle areas. The four mines and associated mill would produce about 1,000 tons of ore per day and would employ about 100 people. Production was to start in 1989.

Steelhead Resources Ltd. announced plans to redevelop the old Great Excelsior gold-silver mine in Whatcom County. The planned $10 to $15 million operation would employ surface mining and a flotation mill. By September, estimated ore reserves totaled more that 4 million tons grading 0.086 ounce of gold and 3.16 ounces of silver per ton. Late in the year, drilling indicated an unquantified expansion of the reserves. The proposed operation would employ between 50 and 100 people for a 10- to 30-year period.

The R. A. Hanson Co. Inc. (RAHCO), Spokane, finished design work and began construction on a $15 million, new concept, double bucketline gold dredge. The machine, designed to dig to a depth of 90 feet, would remove overburden and mine gold-bearing gravels simultaneously. This would cut production costs dramatically for mining low-grade placer deposits. RAHCO and Sydney, Australia-based Giant Resources Ltd. planned a joint gold-dredging venture in New Zealand, starting in mid-1989. RAHCO reportedly was approached by one buyer for additional machines, even though completion of the first was still a year in the future.

Magnesium.—Magnesium metal production increased 11% in quantity and by about 1% in value from that of 1986; the State again ranked second in the Nation for magnesium metal production in 1987. Northwest Alloys, a wholly owned subsidiary of Alcoa, operated at capacity its magnesium metal plant at Addy, Stevens County. Most of Northwest Alloys' production was used by Alcoa as an alloying ingredient in the manufacture of aluminum. The Addy plant produced the metal from locally mined magnesium dolomite, employing a silicothermic process using purchased ferrosilicon and in-plant-manufactured aluminum-quartizite flux; the other two domestic producers recovered magnesium metal through the electrolytic treatment of brines.

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Northwest Alloys sold its process-waste sludge to L-Bar Products, which recovered magnesium salts and metal at a plant in Chewalah, Stevens County.

Silicon.—The M. A. Hanna Co. had a recordbreaking year at the Rock Island silicon metal plant, Douglas County. The plant exceeded by 3% a production record established in 1986. Ferrosilicon, largely consumed by the waning steel industry, was dropped from production in 1987, and the plant's output was diversified into various grades of silicon metal. A revival in the silicon-consuming aluminum industry, increased demand from Japanese producers, and emerging markets for semiconductor-grade silicon for computer chips and silicon-based chemicals all contributed to the company's decision to drop ferrosilicon and devote a third furnace to silicon metal production. The 15,000-short-ton-per-year-capacity plant supplied silicon metal to Pacific Northwest aluminum smelters and to Union Carbide's polycrystalline silicon operation. About 25% of Hanna's silicon metal output was exported to Pacific Rim countries.

Union Carbide Corp. operated a polycrystalline silicon plant at Moses Lake, Grant County.

Steel.—Birmingham Steel Corp. Alabama, completed the $25 million purchase in early January of Seattle-based Northwest Steel Rolling Mills Inc. The operation, renamed Salmon Bay Steel Corp., manufactured reinforcing bars and other steel construction products for west coast markets.

The volume of steel slag sold or used in the State dropped by nearly 6% but the value rose by almost 4% from that of 1986.

Titanium.—Citing a continued slow market for titanium metal, International Titanium Inc. (ITI) closed its Moses Lake titanium sponge plant in Grant County in March. The closure, part of a corporate cost-cutting plan by the parent company, Wyman Gordon Co. of Massachusetts, put 160 employees out of work. The ITI facility, which produced titanium for the aerospace industry, had just spent $3 million on a new emission control system.

[1]State Mineral Officer, Bureau of Mines, Spokane, WA.
[2]Geologist, Washington Division of Geology and Earth Resources, Spokane, WA.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Aluminum Co. of America	Box 221 Wenatchee, WA 98801	Plant	Chelan.
Columbia Aluminum Co	Star Rte. 667, Box 46 Goldendale, WA 98620	do	Klickitat.
Intalco Aluminum Corp	Box 937 Ferndale, WA 98248	do	Whatcom.
Kaiser Aluminum & Chemical Corp.	Box 6217 Spokane, WA 99207	do	Spokane.
Do	3400 Taylor Way Tacoma, WA 98421	do	Pierce.
Reynolds Metals Co	Box 999 Longview, WA 98632	do	Cowlitz.
Vanalco Inc	Box 120 Vancouver, WA 98660	do	Clark.
Cement:			
Ash Grove Cement West Inc	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	do	King.
Ideal Basic Industries Inc	Box 8789 Denver, CO 80201	do	Do.
Lehigh Portland Cement Co	718 Hamilton Mall Box 1882 Allentown, PA 18105	do	Pend Oreille.
Tilbury Cement Co	Box 87, Marietta Rd. Bellingham, WA 98227	do	Whatcom.
Clays:			
Ideal Basic Industries Inc	Box 8789 Denver, CO 80201	Pit	Clallam.
Mutual Materials Co	Box 2009 Bellevue, WA 98009	Pits and plant	King and Pierce.
Diatomite:			
Inorganic Specialties, a division of Witco Corp.	520 Madison Ave. New York, NY 10072	Mine and plant	Grant.
Gold:			
Asamera Minerals (U.S.) Inc	2100, 144 4th Ave. SW. Calgary, AB T2P 3N4 Canada	Underground mine and mill.	Chelan.
Hecla Mining Co.[1]	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814-1931	do	Ferry.

See footnotes at end of table.

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Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime:			
Continental Lime Inc	1220 Alexander Ave. Tacoma, WA 98421	Plant	Pierce.
Northwest Alloys Inc	Box 115 Addy, WA 99101	Mine and plant	Stevens.
Magnesium:			
Northwest Alloys Inc.[2]	Box 138A, Route 1 Addy, WA 99101	do	Do.
Olivine:			
AIMCOR	Box 58 Hamilton, WA 98225	do	Skagit.
Peat:			
Sol Chrystel	Hoquiam, WA 98550	Bog	Grays Harbor.
Maple Valley Humus	18805 SE. 170th St. Renton, WA 98005	Bog	King.
Sand and gravel (industrial):			
Lane Mountain Silica Co	Box 236 Valley, WA 99181	Quarry and plant	Stevens.
L-Bar Products Inc	Box 95 Ravensdale, WA 98051	do	King.
Stone:			
Crushed:			
Cadman Rock Co. Inc	Box 790 Monroe, WA 98272	Quarry	Snohomish.
DeAtley Co., division of Eucon Co.	Box 648 Lewiston, ID 83501	Quarries	Various.
U.S. Forest Service, Region 6	319 SW. Pine St. Portland, OR 97208	do	Do.
Van Eaton & Daniel Crushing Co.	350 Morton Rd., Box K Morton, WA 98532	Quarry	Lewis.
Weyerhaeuser Co., Mineral Resources Div.	Tacoma, WA 98477	Quarries	Various.
Dimension:			
Island Frontier Landscape Construction Co.	435 Gibraltar Rd. Anacortes, WA 98211	do	Skagit.
Mt. Adams Flagstone Co	4594 Woodworth Rd. Hood River, OR 97041	Quarry	Yakima.
Sulfur (recovered):			
Atlantic Richfield Co	4519 Grandview Rd. Ferndale, WA 98248	Plant	Whatcom.
Mobil Oil Corp	3901 Unick Rd. Ferndale, WA 98248	do	Do.
Texaco Inc	600 Texas Rd. Anacortes, WA 98221	do	Skagit.

[1]Also silver.
[2]Also industrial sand and st

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The Mineral Industry of West Virginia

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geological and Economic Survey, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Dewey S. Kirstein[2]

The value of West Virginia's nonfuel mineral production in 1987 was about $144 million. Coal mining is a major industry in West Virginia and the State ranked third nationally in the production of bituminous coal. Aluminum and steel manufacturing also contributed significantly to the State's economy.

About 1,100 mineral producers and processors were reported operating in 1987 by the West Virginia Geological and Economic Survey. Of this total, 100 mined nonfuel minerals, 800 produced coal, and 200 manufactured minerals, primarily metals. Because of the large number of coal mines and production of 137 million short tons of coal, nonfuel minerals are of less economic significance than coal. The coal industry employed about 31,000 workers in 1987 compared with approximately 9,000 workers employed under the category of stone, clay, and glass in the standard industrial classification code.

Table 1.—Nonfuel mineral production in West Virginia[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ____ thousand short tons__	331	$3,342	215	$470	266	$565
Gem stones	--	--	NA	1	NA	1
Salt ____ thousand short tons__	895	W	W	W	W	W
Sand and gravel (construction) ____do____	e900	e3,000	1,501	5,365	e1,000	e3,200
Stone (crushed) ____do____	9,393	38,348	e9,800	e37,500	12,458	50,947
Combined value of cement, lime (1985, 1987), peat, sand and gravel (industrial), and values indicated by symbol W	XX	60,719	XX	86,473	XX	89,308
Total	XX	105,409	XX	129,809	XX	144,021

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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Table 2.—Nonfuel minerals produced in West Virginia in 1986, by county[1]

County	Minerals produced in order of value
Berkeley	Cement, clays.
Grant	Sand and gravel.
Hancock	Do.
Marshall	Salt.
Mason	Sand and gravel.
Morgan	Do.
Wetzel	Do.
Wyoming	Do.
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Legislation and Government Programs.—Legislation restructuring the State's tax system, enacted in 1985, became effective July 1, 1987. The new system changed the severance tax rate; by 1992, the rate for all minerals would be 4% of the gross value. The production of minerals, including coal, generated about $155 million in tax revenues in the fiscal year that ended June 30, 1987. Only the consumers' sales tax and personal income tax generated more tax revenue than mining for West Virginia.

In an attempt to retain industry, Senate bill 310 was enacted to exempt sales of electricity consumed in the manufacture of ferroalloys from the State's business and occupation tax. West Virginia's ferroalloy industry had been adversely affected since the beginning of the decade by a decline in demand from the steel industry and an increase in imports. At yearend, only one company continued ferroalloy production in West Virginia.

The West Virginia Geological and Economic Survey and U.S. Bureau of Mines, through cooperative agreements, had conducted a ceramic raw materials sampling, testing, and evaluation program for a number of years. A review of preliminary firing-test data from that program provided information on sites for potential development of a lightweight aggregate industry in West Virginia. Bulk samples were collected at sites in Greenbrier, Monroe, and Summers Counties, and economic parameters pertaining to mining and production were recorded.[3]

The production of lightweight-concrete building components using fly ash as a base material was assessed in a study by West Virginia University in conjunction with the West Virginia Department of Employment Security. The potential for development of a cellular-concrete building-products industry was considered favorable because large quantities of fly ash are available at electric powerplants, and construction aggregate resources are inherently low in parts of the State.[4]

Research by the U.S. Bureau of Mines continued on treatment of acid mine drainage. Through 1987, research indicated that, with flow control, metal sulfate and acidity removal can be expected in an established constructed wetland. The approach used in constructed biological systems was similar to that used for treatment of stormwater and municipal or industrial wastes. It was estimated that chemical treatment of acid mine drainage cost the mining industry more than $1 million per day.[5]

The West Virginia Department of Natural Resources and the U.S. Forest Service, after a 6-year study of acid precipitation, constructed a $300,000 limestone treatment station on the Cranberry River in Webster County. The Cranberry watershed, which feeds the river, had too few nutrients in the soil and water to neutralize acid precipitation and to support a fish population. By the spring of 1989, it was expected that the river would be able to support fish year-round.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Crushed stone was the dominant nonfuel mineral produced. Other commodities (production and value given in table 1) included cement, common clay, lime, peat, salt, industrial sand, and construction sand and gravel. Because these commodities were produced at only a few operations, output fluctuations typically were minimal and depended primarily on local markets.

With the exception of salt, these commodities were consumed by the construction industry. Salt production increased after labor disputes that began in 1986 were settled and demand from the chemical industry increased.

Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on an-

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nual company estimates.

The construction industry demand from West Virginia and adjacent States resulted in a State record-high output of 12.5 million short tons of crushed stone, surpassing the previous high of 11.7 million tons set in 1973. About 80% of the crushed stone produced in West Virginia was limestone.

Emphasis on and development of clean coal technology (CCT) had expanded in the past few years, coinciding with increased concern and legislation aimed at lowering sulfur dioxide emissions, a component of acid rain. Generally, CCT removes sulfur from coal, with some of the technology requiring as much as 1 ton of limestone for every 3 tons of coal burned. As a leading coal-producing State, West Virginia initiated a proposal in 1986 to construct four 300-megawatt coal-fired powerplants through its Public Energy Authority (PEA). Fluidized-bed combustion technology would be used at these plants, providing a market for crushed limestone.

PEA was investigating the feasibility of supplying electric power to Virginia Electric Power Co. (Vepco), which was soliciting bids to supply 1,750 megawatts of additional power. As part of the planning process, PEA began accepting bids for 140,000 tons of limestone per year for 1995 and 1996 and 280,000 tons per year through 2018. Acceptance of the bids and construction of the powerplants by PEA was dependent on gaining a contract with Vepco to supply the power. A decision by Vepco was expected in late 1988.

In 1985, the U.S. Bureau of Mines began compiling crushed stone statistics by districts for some States. Table 3 presents end-use data for crushed stone produced in the three West Virginia districts depicted in figure 1.

Table 3.—West Virginia: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	177	1,089
Filter stone	89	384
Coarse aggregate, graded:		
Concrete aggregate, coarse	674	2,744
Bituminous aggregate, coarse	241	1,122
Bituminous surface-treatment aggregate	80	275
Fine aggregate (-3/8 inch):		
Stone sand, concrete	144	668
Stone sand, bituminous mix or seal	154	670
Screening, undesignated	73	193
Coarse and fine aggregates:		
Graded road base or subbase	686	4,263
Crusher run or fill or waste	532	2,301
Other construction:[2]	652	2,945
Agricultural: Agricultural limestone	33	318
Special:		
Mine dusting and acid-water treatment	91	W
Other miscellaneous[3]	1,331	4,632
Other unspecified[4]	7,502	29,342
Total[5]	12,458	50,947

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes limestone and sandstone.
[2]Includes macadam, railroad ballast, and unpaved road surfacing.
[3]Includes cement manufacture and other fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.

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Table 4.—West Virginia: Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch)[1]	W	W	W	W	193	1,153
Coarse aggregate, graded[2]	211	957	327	937	493	2,414
Fine aggregate (-3/8 inch)[3]	W	W	W	W	208	762
Coarse and fine aggregates[4]	W	W	W	W	807	4,713
Other construction	1,001	4,621	260	1,098	--	--
Agricultural[5]	14	144	(6)	(6)	(6)	(6)
Chemical and metallurgical[7]	--	--	(6)	(6)	--	--
Special[8]	(6)	(6)	--	--	(6)	(6)
Other miscellaneous	91	1,544	1,329	3,068	22	194
Other unspecified[9]	1,334	4,426	3,663	13,421	2,505	11,495
Total[10]	2,651	11,691	5,579	18,524	4,229	20,732

W Withheld to avoid disclosing company proprietary data; included with "Other construction."
[1]Includes macadam, riprap and jetty stone, and filter stone.
[2]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.
[3]Includes stone sand (concrete and bituminous mix or seal), and fine aggregate (screen).
[4]Includes graded roadbase or subbase, unpaved road surfacing, and crusher run or fill or waste.
[5]Includes agricultural limestone.
[6]Withheld to avoid disclosing company proprietary date; included with "Other miscellaneous."
[7]Includes cement manufacture.
[8]Includes mine dusting and other fillers or extenders.
[9]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[10]Data may not add to totals shown because of independent rounding.

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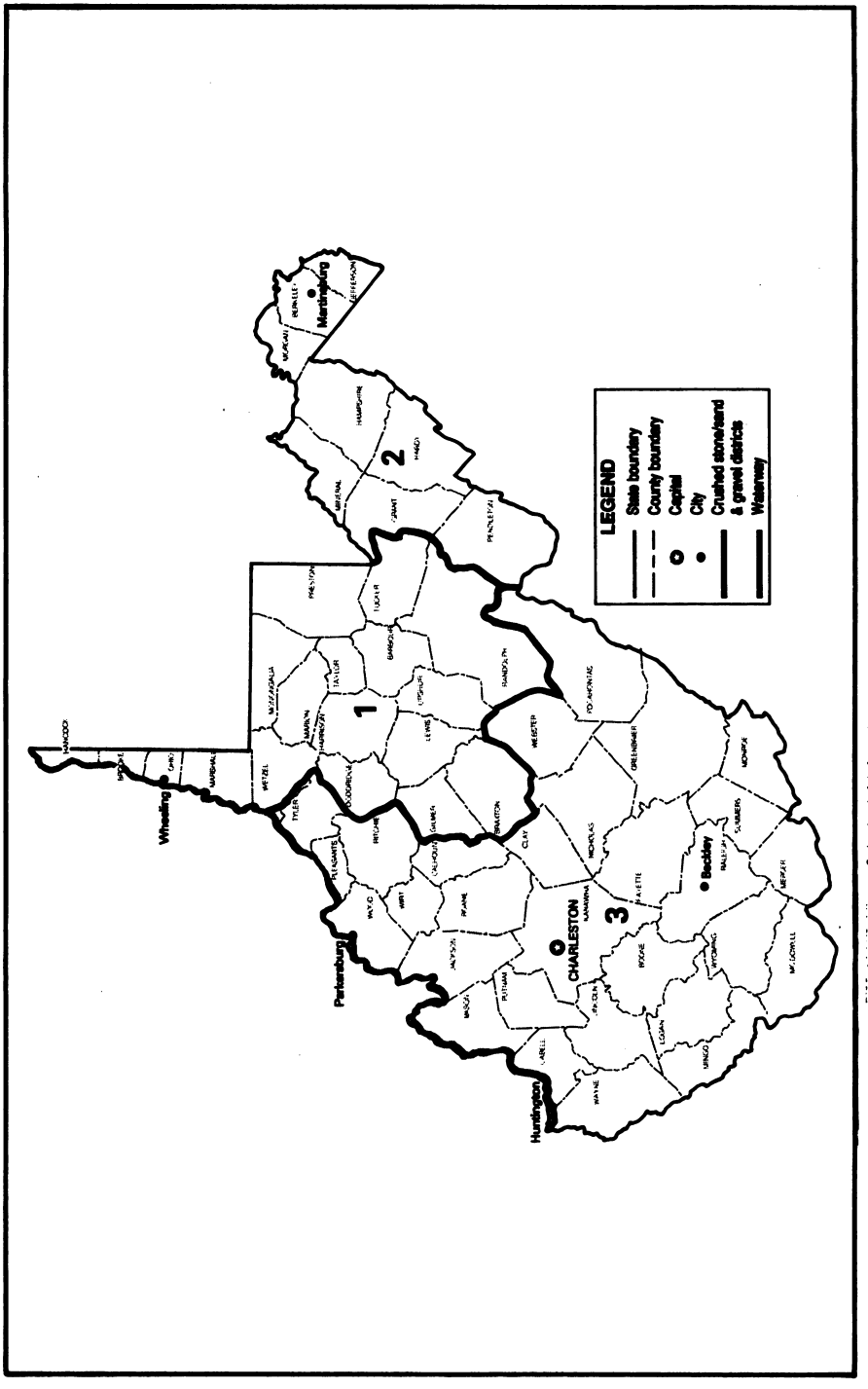

Figure 1.—Aggregate-producing districts in West Virginia.

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METALS

Aluminum.—Kaiser Aluminum & Chemical Corp., the State's sole producer of aluminum, became a subsidiary of Kaiser Tech Ltd. as part of a company restructuring program. The change was aimed at stabilizing the firm's financial position and was not expected to affect operations at the Ravenswood smelter. The Ravenswood operation employs about 2,000 workers and has an annual rated capacity of about 4% of the total U.S. aluminum capacity. Late in the year, one-half of an idled aluminum making potline was returned to production as a result of improved demand and higher prices.

Iron and Steel.—West Virginia produced about 5% of the Nation's steel in 1987. Weirton Steel Corp. and Wheeling-Pittsburgh Steel Corp. operated integrated mills and the Steel of West Virginia minimill. Employment at these operations accounted for about 15% of the State's total employment in manufacturing.

Weirton Steel continuously cast about 60% of its output, which is similar to the national percentage for that type of steelmaking. About two-thirds of Weirton's shipments were steel sheets and one-third tin mill products.

Other Metals.—Inco Alloys International Inc. continued to produce wrought high-nickel alloys at its Huntington plant in Cabell County. The Meadowbrook Corp., a wholly owned subsidiary of T. L. Diamond & Co. Inc., operated a zinc plant at Spelter, Harrison County. Corhart Refractories Co. produced high-density zircon and chromic oxide refractory brick using imported ores at its Buckhannon plant in Upshur County. Elkem Metals Co. produced silicon metal at its plant in Alloy.

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[1]State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

[2]Economic Geologist and Head, Economic Section, West Virginia Geological and Economic Survey, Morgantown, WV.

[3]Devore, P. W., and T. R. Mounkurai. Production of Autoclaved Cellular Concrete Building Products Utilizing Pulverized Fly Ash. West Virginia Univ. Program for the Study of Technology, Morgantown, WV. June 1987, 201 pp.

[4]Kirstein, D. S. Rocks That Float. Mountain State Geol., 1988, pp. 10-13.

[5]Kleinmann, R. L. P. A Biological Alternative to Conventional AMD Treatment. Green Lands, Spring 1987, pp. 30-33.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Capitol Cement Corp.[1]	Box 885 Martinsburg, WV 25401	Quarry and plant	Berkeley.
Clays:			
Continental Brick Co	Box 1111 Martinsburg, WV 25401	Pit and plant	Do.
Sanders Dummy Co	Box 24 Midkiff, WV 25504	Pit	Lincoln.
Lime:			
Germany Valley Limestone Co	Box 302 Riverton, WV 26814	Quarry and plant	Pendleton.
Salt:			
LCP Chemicals-West Virginia Inc.	Drawer J Moundsville, WV 26041	Brine wells and plant	Marshall.
PPG Industries Inc	1 Gateway Center Pittsburgh, PA 15222	____do	Do.
Sand and gravel:			
Construction:			
Dravo Corp	1 Oliver Plaza Pittsburgh, PA 15222	Dredges	Various.
ET&S Inc	Route 1 Cheshire, OH 45620	Quarry and plant	Mason.
Mason County Sand & Gravel Inc.	Route 2, Box 166-A Letar, WV 25253	____do	Do.
Standard Slag Co	Box 448 Weirton, WV 26062	Plant	Hancock.
Industrial:			
Tolers Sand Co	Route 1,Box 132B Welch, WV 24801	Dredge	Wyoming.
United States Borax & Chemical Corp.	Box 187 Berkeley Springs, WV 25411	____do	Do.
Stone:			
J. F. Allen Co	Box 49 Clarksburg, WV 26301	Quarry	Randolph.
Fairfax Sand & Crushed Stone Co.	Box 98 Thomas, WV 26292	Quarries	Grant, Mineral, Randolph Tucker.
Greer Limestone Co., a division of Greer Steel Co.	Greer Bldg. Morgantown, WV 26505	Mine and quarries	Monongalia and Pendleton.
USX Corp	600 Grant St. Pittsburgh, PA 15230	Quarry	Jefferson.

[1]Also clays and crushed stone.

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The Mineral Industry of Wisconsin

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Wisconsin Geological and Natural History Survey for collecting information on all nonfuel minerals.

By James J. Hill[1] and Thomas J. Evans[2]

Wisconsin's nonfuel mineral production was valued at $191.6 million in 1987. The State ranked 36th nationally in value of nonfuel mineral output. Construction sand and gravel and crushed stone continued to contribute the greatest amount to the State's total mineral production value, accounting for 67% in 1987. Wisconsin's two cement grinding plants were not in operation during the year and instead were utilized as distribution terminals. Iron oxide pigments, perlite, and vermiculite from out-of-State sources were processed in the State. Sulfur was recovered as a petroleum refinery byproduct. No metallic minerals were mined in Wisconsin.

Table 1.—Nonfuel mineral production in Wisconsin[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	--	--	NA	15	NA	15
Lime thousand short tons	341	19,001	350	19,715	393	21,733
Peat do	10	W	9	W	9	W
Sand and gravel:						
Construction do	e16,000	e36,000	24,913	59,325	e23,900	e57,000
Industrial do	1,197	14,624	1,194	12,399	1,314	15,168
Stone:						
Crushed thousand short tons	14,496	$42,380	e18,700	e$57,600	2r22,757	2r$71,776
Dimension do	22	2,733	e23	e2,878	37	3,697
Combined value of abrasives, cement, stone (crushed traprock, 1987), and values indicated by symbol W	XX	10,372	XX	12,600	XX	22,233
Total	XX	125,110	XX	164,532	XX	191,622

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Wisconsin in 1986, by county[1]

County	Minerals produced in order of value
Adams	Sand and gravel (construction).
Ashland	Do.
Barron	Do.
Bayfield	Do.
Brown	Lime, sand and gravel (construction).
Buffalo	Sand and gravel (construction).
Burnett	Do.
Calumet	Do.
Chippewa	Do.
Clark	Do.
Columbia	Sand (industrial), sand and gravel (construction).
Crawford	Sand and gravel (construction).
Dane	Do.
Dodge	Lime, sand and gravel (construction).
Door	Sand and gravel (construction).
Douglas	Lime, cement, sand and gravel (construction).
Dunn	Sand and gravel (construction).
Eau Claire	Do.
Florence	Do.
Fond du Lac	Lime, sand and gravel (construction).
Forest	Sand and gravel (construction).
Green Lake	Sand (industrial), sand and gravel (construction).
Iron	Sand and gravel (construction).
Jackson	Sand (industrial), sand and gravel (construction).
Jefferson	Sand and gravel (construction).
Juneau	Do.
Kenosha	Do.
Kewaunee	Sand and gravel (construction), peat.
La Crosse	Sand and gravel (construction).
Langlade	Do.
Lincoln	Do.
Manitowoc	Lime, sand and gravel (construction).
Marathon	Sand and gravel (construction).
Marinette	Do.
Marquette	Do.
Milwaukee	Cement.
Oconto	Sand and gravel (construction).
Oneida	Do.
Outagamie	Do.
Ozaukee	Do.
Pepin	Do.
Pierce	Sand and gravel (construction), sand (industrial).
Polk	Sand and gravel (construction).
Portage	Do.
Price	Do.
Racine	Do.
Richland	Do.
Rock	Do.
Rusk	Do.
St. Croix	Do.
Sauk	Sand and gravel (construction), abrasives.
Sawyer	Sand and gravel (construction).
Shawano	Do.
Sheboygan	Do.
Taylor	Do.
Trempealeau	Do.
Vilas	Do.
Walworth	Do.
Washburn	Do.
Washington	Do.
Waukesha	Sand and gravel (construction), peat.
Waupaca	Sand and gravel (construction), sand (industrial).
Waushara	Sand and gravel (construction).
Winnebago	Sand (industrial).
Undistributed[2]	Stone (crushed and dimension), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

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Trends and Developments.—In May, Kennecott Exploration (Australia) Ltd. announced plans to pursue development of a small massive sulfide copper deposit (Flambeau) that it discovered in 1968 south of Ladysmith in the Town of Grant, Rusk County. The company had applied for a mining permit for the deposit in 1976, but it could not obtain county zoning approval. Kennecott had planned to develop an open pit with an 11-year life followed by an underground operation for an additional 11 years. The company's new plan was to scale back the operation and focus on the deposit's secondary enrichment zone, which was 9.5% to 10% copper and had some gold and silver. Proposed was a small (30- to 40-acre) open pit with a maximum depth of 225 feet. Topsoil, overburden, and waste rock would be stored at the minesite and used later to backfill and reclaim the open pit. The ore, predominantly bornite and chalcocite, would be mined at a rate of 1,000 tons per day, crushed, and shipped out of State for smelting and refining. Mining would take place over 5 years after 1 year of mine construction; reclamation would take 2 years. Total cost of the proposed development would be in excess of $30 million. During the year, Kennecott began collecting environmental baseline data to support a mine-permit application that it expected to submit to the Department of Natural Resources (DNR) in mid-1989.

Employment.—Wisconsin's total civilian labor force was reported by the State's Department of Industry, Labor & Human Relations to be 2.5 million in 1987. This was almost a 4% increase over the 1986 figure. The State's average unemployment rate was 6.1%. Mining employment averaged 1,923 workers, a slight increase over the 1986 figure. Average annual wages for mining employees were $25,486 compared with $24,162 in 1986.

Exploration Activities.—Exploration drilling for metallic minerals continued at a modest pace in 1987 with three companies drilling 32 holes for a total of 20,220 feet, compared with 23 holes totaling 15,480 feet in 1986. Some of the expanded activity was attributed to Kennecott's evaluation of the northeast end of the Flambeau copper deposit in Rusk County, where it drilled nine holes. Other companies that were active in drilling included Chevron USA Inc. with 11 holes and Noranda Exploration Inc. with 12 holes. Drilling was performed in Lincoln, Marathon, and Taylor Counties. The June 1987 issue of The Canadian Mining Journal described one core from the Noranda's Reef Prospect in Marathon County as having a 3-meter section grading 9.2 grams of gold per ton and 1.3% copper.

Leasing for metallic minerals increased in 1987 with about 10,000 acres newly leased in six counties compared with slightly more than 1,500 acres in all of 1986. In order of acres leased, Taylor, Rusk, and Price Counties received the most attention. Chevron leased the most acreage, 6,000 acres, from the Soo Line Railroad Co.

Mineralco Inc. of Ottawa, IL, failed in its attempt to obtain a State lease on lands underlying Hixon Lake in Oneida County, where it was seeking to test drill a geophysical anomaly for gold. The Wisconsin Natural Resources Board did not approve the proposal in December when some members feared that it would set an unwanted precedent for mineral exploration under lakes and wetlands in northern Wisconsin. Currently, Wisconsin has no State-owned metallic mineral rights under lease.

Oneida County, in the north-central part of the State, initiated a program that may lead to competitive mineral leasing of county forest lands as early as 1989. A draft program was developed in consultation with the Wisconsin Geological and Natural History Survey and the University of Wisconsin—Extension and presented to the Forestry and Parks Committee on the county board near yearend for consideration and possible refinement.

Shipping.—The Port of Duluth-Superior handled 34.6 million metric tons of waterborne commerce in 1987, a 26.7% increase over the 27.3 million tons reported in 1986. Most of the rise in tonnage was attributed to increased shipments of iron ore and coal. Taconite pellets from the western Mesabi Range in Minnesota were shipped by rail to Burlington Northern Railroad's docks in Superior. In 1987, the American Iron Ore Association reported shipments of 11.2 million gross tons from the Superior docks, compared with 9.0 million tons in 1986. The first vessel was loaded out on March 24th and the last on January 7, 1988. The Superior Midwest Energy Terminal transshipped a record-high 11.2 million short tons of Montana coal to electric generating plants on the Great Lakes, surpassing its previous high of 8.2 million tons set in 1986. The first cargo was loaded out on March 30th and the last on December 18th. Most of the coal went to Detroit Edison Co.'s generating

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plants at St. Clair, MI; about 1.2 million tons went to the Upper Peninsula Generating Co.'s Presque Isle facility in Marquette, MI.

The Port of Green Bay reported 1.7 million short tons of waterborne commerce in 1987, down almost 25% from 1986 figures. Major commodities entering the port, in decreasing order of tonnage, were coal, cement, limestone, and salt. Reduced receipts of coal and cement accounted for most of the decline in tonnage.

Total waterborne commerce at the Port of Milwaukee increased about 18% in 1987 to about 2.2 million short tons. Grain shipments increased the most during the year. Port receipts of selected nonfuel mineral commodities are shown in table 3.

Table 3.—Port of Milwaukee: Selected nonfuel mineral commodity imports[1]

(Short tons)

Commodity	1986	1987
Cement	387,377	465,749
Limestone	21,397	20,827
Pig iron	39,639	54,052
Salt	490,541	399,620
Sand	32,551	32,798
Total	971,505	973,046

[1]Includes Canadian imports and domestic receipts.

Source: 1987 Annual Report, Port of Milwaukee, U.S.A.

Legislation and Government Programs.—On July 1, the State's Severed Mineral Interest Act (Wisconsin Act 455 of 1984) came into effect and for the first time allowed surface owners to file claim to severed mineral interests that had not been registered under the act. The purpose of the act was to clear up land titles where owners of severed mineral interests were either unknown or had not used the mineral interests for at least 20 years.

The Wisconsin Geological and Natural History Survey continued bedrock and surface geological mapping. Two major bedrock geology maps, the Northwest and West Central sheets (scale 1:250,000) were ready for cartographic preparation. In addition, the Survey published reports on the Pleistocene geology of Adams and Forest Counties and on the soils and their contaminant attenuation capability in Adams, Barron, Chippewa, Dunn, Pierce, Portage, St. Croix, and Wood Counties.

During the year, the Survey acquired more than 70,000 feet of drill core from the U.S. Bureau of Mines holdings at Fort Snelling, MN, for its Milwaukee core library, in addition to core donated by mineral exploration firms. The Bureau of Mines released RI 9116, "Sampling, Characterization, and Evaluation of Midwest Clays for Iron Ore Pellet Bonding," which included some data on Wisconsin clay samples.

REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Lime.—Wisconsin ranked 14th of 34 States in sales of lime. Three companies produced lime at five plants. Both sales and value of sales increased modestly during 1987. Average value per ton dropped $1.05 to $55.30 per ton. Lime consumption in Wisconsin during 1987 totaled 137,000 short tons of quicklime and 43,000 tons of hydrated lime, a 41% increase for quicklime and a 9% decrease for hydrated lime compared with 1986 figures.

Sand and Gravel.—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the second leading mineral commodity produced in the State, following crushed stone. Production and value were estimated to have declined about 4% in 1987.

Industrial.—Four companies produced sand for industrial purposes in six counties. Green Lake County led the State's production. Major sales of sand were for foundry use, hydraulic fracturing, and making glass containers. Lesser amounts were for sandblasting, locomotive traction, and filtration. Production increased about 10% in 1987, value increased 22%. Average value of sales was $11.55 per short ton, an increase of about 11%. Fifty-four percent of the sales was shipped by truck, the rest by rail.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates.

Crushed.—In terms of value, crushed

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stone was the leading mineral commodity produced in Wisconsin. Output increased about 22% in 1987, value increased nearly 25%. Production occurred in 45 of the State's 72 counties, in 194 quarries. Marathon County led the State's production. Limestone-dolomite generated the greatest value of sales, followed by sandstone, granite, and traprock.

Table 5 presents end-use data for crushed stone produced in the eight Wisconsin districts depicted in figure 1.

Dimension.—Wisconsin ranked 12th of 35 States in the production of dimension stone. Production and value increased 61% and 28%, respectively, when compared with 1986 figures. Output was from 16 quarries in 8 counties by 13 companies. Three types of stone were produced in Wisconsin: granite, limestone-dolomite, and sandstone. Most of the State's dimension granite was produced in Marathon County. Manitowoc County led in the production of dimension limestone-dolomite. Dressed monumental stone (granite) commanded the highest value.

Other Industrial Minerals.—Wisconsin was one of two States that produced small quantities of abrasive stone as a deburring media. Both production and value increased modestly during 1987. The State's two cement grinding plants were used as distribution terminals the entire year and shipped finished cement made in Canada and Michigan to customers. Sales and value of sales increased for both masonry and portland cement. Peat sales remained about the same as in 1986. Sulfur recovered as a byproduct at the State's lone petroleum refinery increased $6.37 per metric ton. Total sales dropped 18%. Perlite and vermiculite mined in other States were processed in Wisconsin. perlite increased nearly 25%; vermiculite sales dropped 38%.

[1]State Mineral Officer, Bureau of Mines, Minneapolis, MN.
[2]Associate professor, Minerals Information, Wisconsin Geological and Natural History Survey, Madison, WI.

Table 4.—Wisconsin: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch):		
Riprap and jetty stone	233	1,828
Filter stone	75	192
Coarse aggregate, graded:		
Concrete aggregate, coarse	1,139	3,880
Bituminous aggregate, coarse	817	2,377
Bituminous surface-treatment aggregate	367	933
Fine aggregate (-3/8 inch):		
Screenings, undesignated	202	401
Coarse and fine aggregates:		
Graded road base or subbase	6,003	16,579
Unpaved road surfacing	1,154	4,096
Crusher run or fill or waste	338	745
Other construction[2]	326	898
Agricultural:		
Agricultural limestone	875	4,451
Other agricultural uses	W	21
Special: Other miscellaneous[3]	819	3,873
Other unspecified[4]	10,409	31,552
Total	22,757	71,776

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes limestone, granite, and sandstone; excludes a minor amount of traprock to avoid disclosing company proprietary data.
[2]Includes other coarse aggregate, macadam, railroad ballast, stone sand (concrete and bituminous mix or seal).
[3]Includes cement manufacture, lime manufacture, chemical stone for alkali works, other fillers or extenders, roofing granules, and data indicated by symbol W.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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Table 5.—Wisconsin:[1] Crushed stone sold or used by producers in 1987, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (+1-1/2 inch)[2]	30	129	318	2,160	39	133	--	--
Coarse aggregate, graded[3]	143	430	1,326	4,546	473	1,098	--	--
Fine aggregate (-3/8 inch)[4]	16	50	--	--	W	W	--	--
Coarse and fine aggregates[5]	1,005	2,759	2,977	9,067	1,030	2,557	352	1,123
Other construction	--	--	(6)	2	157	296	129	193
Agricultural[7]	232	1,024	174	1,502	133	353	(6)	(6)
Chemical and metallurgical[9]	--	--	--	--	105	218	--	--
Special[10]	--	--	(6)	(6)	(6)	(6)	--	--
Other miscellaneous	--	--	20	48	644	3,446	25	80
Other unspecified[11]	3,255	9,544	1,894	7,158	2,398	6,859	1,647	4,227
Total[12]	4,681	13,936	6,708	24,482	4,979	14,961	2,153	5,623

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (+1-1/2 inch)[2]	W	W	W	W	--	--	--	--
Coarse aggregate, graded[3]	323	1,040	19	44	--	--	--	--
Fine aggregate (-3/8 inch)[4]	W	W	--	--	--	--	10	25
Coarse and fine aggregates[5]	1,180	3,635	421	1,180	--	--	--	--
Other construction	38	111	6	18	--	--	--	--
Agricultural[7]	197	799	(6)	(6)	--	--	34	219
Chemical and metallurgical[9]	--	--	--	--	--	--	--	--
Special[10]	--	--	--	--	--	--	--	--
Other miscellaneous	44	131	77	502	--	--	--	--
Other unspecified[11]	566	1,730	159	476	--	--	490	1,559
Total[12]	2,347	7,446	682	2,220	--	--	534	1,803

W Withheld to avoid disclosing individual company proprietary data; included with "Other construction."

[1]Excludes 672,212 short tons valued at $1,305,353 not reported by county and a minor amount of traprock to avoid disclosing company proprietary data.

[2]Includes macadam, riprap and jetty stone, filter stone, and coarse aggregate (large).

[3]Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, and railroad ballast.

[4]Includes stone sand (concrete and bituminous mix or seal) and fine aggregate (screenings).

[5]Includes graded road base, or subbase, unpaved road surfacing, and crusher run or fill or waste.

[6]Less than 1/2 unit.

[7]Includes agricultural limestone and other agricultural uses.

[8]Withheld to avoid disclosing individual company proprietary data; included with "Other miscellaneous."

[9]Includes cement manufacture, lime manufacture, and chemical stone for alkali works.

[10]Includes other fillers or extenders and roofing granules.

[11]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[12]Data may not add to totals shown because of independent rounding.

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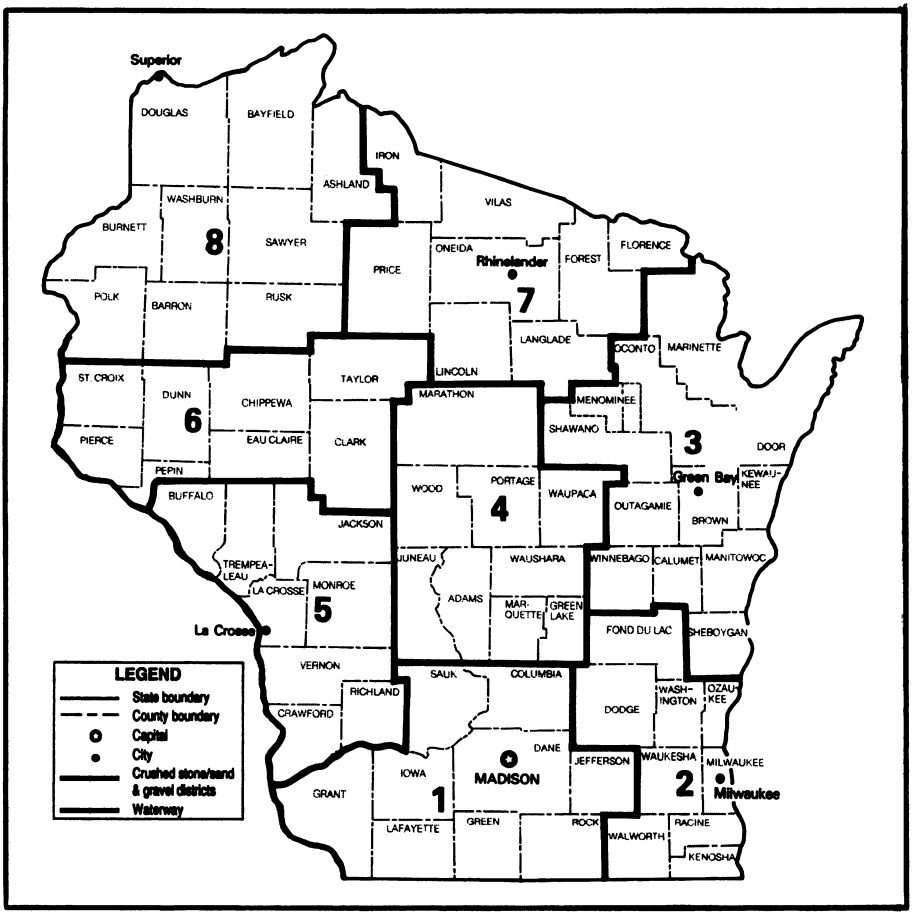

Figure 1.—Aggregate-producing districts in Wisconsin.

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Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Baraboo Quartzite Co. Inc	Box 123 Baraboo, WI 53913	Quarry and plant	Sauk.
Cement:			
Lafarge Corp., Great Lakes Region.	4000 Town Center Suite 2000 Southfield, MI 48075	Inactive grinding plant.	Douglas.
St. Marys Wisconsin Cement Inc., a subsidiary of St. Marys Cement Ltd.	9333 Dearborn St. Detroit, MI 48209	do	Milwaukee.
Iron oxide pigments (finished):			
DCS Color & Supply Co. Inc	2011 South Allis St. Milwaukee, WI 53207	Plant	Do.
Lime:			
CLM Corp	Box 16807 Duluth, MN 55816	do	Douglas.
Rockwell Lime Co	4223 Rockwood Rd. Manitowoc, WI 54220	do	Manitowoc.
Western Lime & Cement Co	Box 57 West Bend, WI 53095	Plants	Brown, Dodge, Fond du Lac.
Peat:			
Bogda's Top Soil & Excavating Co.	12600 West Cleveland Ave. New Berlin, WI 53151	Bog and plant	Waukesha.
Certified Peat & Sod Inc	19000 West Lincoln Ave. New Berlin, WI 53151	do	Do.
Demilco Inc., a division of Nitragin Co. Inc.	3101 West Custer Ave. Milwaukee, WI 53209	do	Do.
Honest To Peat Inc	Route 2 Algoma, WI 54201	Bog	Kewaunee.
Perlite (expanded):			
Midwest Perlite Co	4280 Parkway Blvd. Appleton, WI 54915	Plant	Outagamie.
Sand and gravel:			
Construction (1986):			
Janesville Sand & Gravel Co., Lycon Inc.	Box 427 Janesville, WI 53545	Pits and plants	Columbia, Dane, Rock.
Johnson Sand & Gravel Inc	N8 W22590 Johnson Dr. Waukesha, WI 53186	do	Waukesha.
Edward Kraemer & Sons Inc	1 Plainview Rd. Plain, WI 53577	do	Various.
Mann Bros. Sand & Gravel Inc.	Box 48 Elkhorn, WI 53121	do	Columbia, Crawford, Kenosha, Rock, Walworth.
Arthur Overgaard Inc	Box 87 Elroy, WI 53929	do	Adams and Juneau.
Park View Sand & Gravel Inc.	S2L West Westmoreland Rd. Waukesha, WI 53186	Pit and plant	Waukesha.
Wissota Sand & Gravel Co	Box 1268 Eau Claire, WI 54701	Pits and plants	Barron, Sawyer, Washington.
Industrial:			
Badger Mining Corp	Box 97 Fairwater, WI 53931	do	Green Lake and Jackson.
A. F. Gelhar Co. Inc	Box 209 Berlin, WI 54923	do	Waupaca and Winnebago.
Treco Sales Inc	Box 38 Bay City, WI 54723	Underground mine and plant.	Pierce.
Unimin Corp	258 Elm St. New Canaan, CT 06840	Pit and plant	Columbia.
Stone:			
Crushed:			
Granite:			
Boon Construction Inc	Route 3, Box 61-H Neillsville, WI 54456	Quarry and plant	Wood.
Kafka Excavating & Granite.	101 South Weber Ave. Stratford, WI 54484	Quarries and plant	Marathon.
Roehl Granite Inc	2200 South Hwy 107, Mosinee, WI 54445	Quarry and plant	Do.
Limestone and dolomite:			
4X Corp	Box 509 Neenah, WI 53929	Quarries and plants	Calumet, Fond du Lac, Winnebago.
C. C. Linck Inc	1226 North Center St. Beaver Dam, WI 53916	do	Various.
Arthur Overgaard Inc	Box 87 Elroy, WI 53929	do	Buffalo, Juneau, La Crosse, Monroe, St. Croix.
Vulcan Materials Co., Midwest Div.	Box 6 Countryside, IL 60525	do	Milwaukee, Racine, Waukesha, Winnebago.

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Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Crushed —Continued			
Sandstone and quartzite:			
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	Quarry and plant	Sauk.
Minnesota Mining & Manufacturing Co.	3M Center St. Paul, MN 55101	____do _____	Marathon.
Traprock (basalt):			
Dresser Traprock Inc __	Box 517 Dresser, WI 54009	____do _____	Polk.
GAF Chemicals Corp __	Box 630 Pembine, WI 54156	____do _____	Marinette.
Dimension:			
Granite:			
Anderson Bros. & Johnson Co.	Box 26 Wausau, WI 54401	Quarries and plant	Marathon and Marinette.
Cold Spring Granite Co _	202 South 3d Ave. Cold Spring, MN 56320	Quarry_____	Marathon.
Lake Wausau Granite Co.	Box 397 Wausau, WI 54401	Quarry and plant	Do.
Limestone and dolomite:			
Buechel Stone Corp ___	West 3639 Hwy. H Chilton, WI 53014	Quarries and plant	Calumet and Fond du Lac.
Fond du Lac Stone Co. Inc.	Box 148 Fond du Lac, WI 54935	Quarry and plant	Fond du Lac.
R. & T. Quality Stone Inc.[1]	Box 182 Lannon, WI 53046	____do _____	Waukesha.
Valders Stone & Marble Inc	Box 35 Valders, WI 54245	____do _____	Manitowoc.
Wislanco Stone Co. Inc _	Box 312 Lannon, WI 53046	____do _____	Waukesha.
Sandstone:			
Klesmith Stone Co____	1633 West River Dr. Stevens Point, WI 54481	Quarry_____	Wood.
Sulfur (recovered):			
Murphy Oil USA Inc_____	Box 2066 Superior, WI 54880	Byproduct sulfur recovery plant.	Douglas.
Vermiculite (exfoliated):			
Koos Inc _____	4500 13th Ct. Kenosha, WI 53140	Plant_____	Kenosha.

[1]Also crushed limestone.

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The Mineral Industry of Wyoming

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Wyoming for collecting information on all nonfuel minerals.

By W. L. Rice[1] and Gary B. Glass[2]

The value of Wyoming's 1987 nonfuel mineral production was $645 million, an increase of 16% from that of 1986. A substantial increase in the value of sodium carbonate (soda ash) production, coupled with a tenfold rise in the value of Grade-A helium output and a significant increase in sodium bentonite production, accounted for the rise in value.

All of the State's nonfuel mineral production in 1987 was in industrial minerals. Soda ash was the leading commodity in terms of value, followed by bentonite, Grade-A helium, crushed stone, and cement. Wyoming ranked first nationally in bentonite and soda ash production; it was second in production of Grade-A helium and elemental sulfur. The State was 15th in the Nation in the value of nonfuel minerals, down from the 14th ranking achieved in 1985 and 1986.

Table 1.—Nonfuel mineral production in Wyoming[1]

Mineral	1985		1986		1987	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons	2,302	$64,146	1,762	$51,823	[2]2,128	[2]$62,031
Gem stones	NA	225	NA	225	NA	150
Gypsum ---------- thousand short tons	[r]404	[r]3,135	W	W	W	W
Lime ---------- do	W	W	25	1,689	29	1,560
Sand and gravel (construction) ---- do	[e]3,500	[e]11,000	3,377	10,977	[e]2,600	[e]9,000
Stone (crushed) ---------- do	[3]2,030	[3]7,329	[e] [3]1,700	[e] [3]5,900	3,171	15,049
Combined value of beryllium concentrates (1986), cement (masonry, 1986-87, and portland), clays (common, 1987), helium (Grade-A, 1986-87), sodium carbonate (natural), stone (crushed granite, 1985-86), and values indicated by symbol W ----------	XX	465,275	XX	[r]484,196	XX	557,265
Total ----------	XX	[r]551,110	XX	[r]554,810	XX	645,055

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

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Table 2.—Nonfuel minerals produced in Wyoming in 1986, by county[1]

County	Minerals produced in order of value
Albany	Cement, sand and gravel (construction), gypsum.
Big Horn	Clays, gypsum, sand and gravel (consrtuction).
Campbell	Sand and gravel (construction).
Carbon	Do.
Converse	Do.
Crook	Clays.
Fremont	Sand and gravel (construction), beryllium.
Goshen	Sand and gravel (construction).
Hot Springs	Do.
Johnson	Clays, sand and gravel (construction).
Laramie	Sand and gravel (construction).
Lincoln	Sand and gravel (construction), helium.
Natrona	Sand and gravel (construction), clays.
Niobrara	Sand and gravel (construction).
Park	Gypsum, sand and gravel (construction).
Platte	Sand and gravel (construction).
Sheridan	Do.
Sublette	Do.
Sweetwater	Sodium carbonate, sand and gravel (construction).
Teton	Sand and gravel (construction).
Uinta	Sand and gravel (construction), clays.
Washakie	Do.
Weston	Clays, sand and gravel (construction).
Undistributed[2]	Stone (crushed), gem stones.

[1]No production of nonfuel mineral commodities was reported for counties not listed.
[2]Data not available by county for minerals listed.

Trends and Developments.—The State's 1987 soda ash production exceeded the record volume attained in 1986. The increase largely was attributed to increased exports and to gains in the domestic glass industry, where soda ash is a primary constituent. The Japanese market, which had been reluctant to accept U.S. soda ash, showed signs of opening up by yearend, indicating a potential for further production increases in 1988.

The trend toward foreign ownership of Wyoming's soda ash industry continued with the sale of the Stauffer Chemical Co. operation to a French concern. By yearend, about 45% of the nameplate capacity of Wyoming's soda ash industry was owned by non-U.S. corporations.

Countering a national trend, Wyoming bentonite production increased slightly over the depressed levels prevalent during the past several years; a modest upturn in oil and gas well drilling was largely responsible for the increase. One new bentonite producing company applied for operating permits, and established companies reported increased business toward the end of the year.

The first full year of Grade-A helium production from a new extraction operation in southwestern Wyoming added a substantial amount to the State's nonfuel mineral production value. A diversity of new uses for helium in scientific and industrial applications ensured that the gas will continue to be an important commodity to Wyoming's mineral industry.

Employment.—Overall mining employment for 1987, including petroleum, uranium, and coal workers, declined to 18,200 from the 22,400 reported in 1986. According to the Wyoming Employment Security Commission, average weekly earnings for the State's mineral industry production workers rose to $611, up from the $596 recorded in 1986. Average hourly wage for the State's mineral industry workers was $14.43 in 1987, compared with the national average of $12.45; mineral industry workers again were the highest paid group in the private, nonfarm industries wage sector in 1987.

Environmental Issues.—The State received two grants from the U.S. Department of the Interior to reclaim abandoned mine land. The first grant, for $13.7 million, included $12.6 million to reclaim a 60-acre uranium complex in Carbon County; the remaining $1.1 million was slated for reclamation of 22 smaller abandoned mines in Hot Springs and Fremont Counties. These properties comprised 13 gold mines, 6 coal mines, 2 uranium mines, and 1 copper mine.

The second grant, for $3.8 million, was issued to cover reclamation of 3 abandoned coal mines and 20 abandoned bentonite mines in Johnson, Natrona, Campbell, and Sheridan Counties. The Land Quality Division of the Wyoming Department of Environmental Quality (DEQ) commenced a program to reclaim abandoned bentonite pits in Weston and Crook Counties. The program involved reclamation of pits at 17 different sites, and when completed will have resulted in filling a total of 87 pits. Thirty pits will not be filled but will be modified to provide enhanced wildlife habitat.

Andover Resources Corp., lessees of the closed Ferris-Haggerty copper-gold mine in the Encampment District, Carbon County,

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continued work with the DEQ to alleviate a copper pollution problem in Haggerty Creek stemming from the old mine. In 1986, Andover had reduced the copper sulfate content in outflowing mine water by 83% to 3 milligrams of copper per liter; in 1987, the company worked toward attaining the 0.15-milligram-per-liter limit set by the DEQ.

Exploration Activities.—The level of exploration for precious metals and industrial minerals in Wyoming increased from the activity recorded in 1986. The most significant gold exploration was in the South Pass-Atlantic City District, in the Wind River Range, Fremont County. Consolidated McKinney Resources Ltd. dewatered the Carrissa Mine and continued exploration on the surface and underground. The Gyorvary Mining Co. worked on a mill at the Mary Ellen property, and Gold N' Oil Corp. acquired additional claims preparatory to exploring the Tabor Grand property. An unknown amount of gold was recovered from placer mines on Rock Creek, Wilson Bar, and Smith Gulch, and placer exploration occurred at several locations in the South Pass Greenstone Belt. At least four Australian companies had land positions in the district. Significant gold mineralization had been identified by the Geological Survey of Wyoming (GSW) at several locations during the past four field seasons, and the GSW continued research on the mineralization and host rocks.

At least three major mining companies continued exploring and drilling low-grade epithermal gold and rare-earth deposits in the Bear Lodge Mountains, Crook county.

Caledonia Resources drilled on the Copper King property in the Silver Crown District, Laramie County. Early drilling results in the disseminated gold-copper Proterozoic porphyry reportedly encountered 0.01 to 0.177 troy ounce of gold per ton over substantial thicknesses and widths. Four major mining companies explored and drilled for platinum-group metals in the Lake Owens and Mullen Creek layered mafic complexes in the Medicine Bow Mountains, Albany and Carbon Counties. Platinum and palladium mineralization was discovered at some locations, but no major discoveries were announced.

In the area of industrial minerals, FMC Corp. continued developmental tests and exploration for new trona reserves suitable for mining by solution methods.

Exploration continued for construction aggregate and construction clay deposits for use in highway and silo construction for MX missiles. The Union Pacific and Burlington Northern Railroads continued to search for additional railroad ballast sources.

The GSW explored silica sand deposits in the State, and two deposits, one at Plumbago Creek north of Laramie, and one near Glendo, were drilled. Several glassmaking companies have expressed interest in these deposits. Other silica sand occurrences that received attention were near Greybull, in the Rattlesnake Hills west of Casper, in the Gas Hills east of Riverton, and in dune sands north of Casper and northeast of Rock Springs.

Legislation and Government Programs.—The total taxable valuation of property in Wyoming for 1987 was $5.97 billion, down 23% from that of 1986. The valuation on minerals produced was nearly 60% of that total: oil accounted for 40%; natural gas, 25%; coal, 31%; trona (soda ash), 3%; and other minerals, 1%. Minerals producers paid $239 million in ad valorem taxes, of which trona and other nonfuel minerals contributed $9.4 million. Severance taxes collected on mineral production amounted to nearly $26.2 million; $6.4 million was derived from trona and other nonfuel minerals. All mineral income—taxes, rents, and royalties—accruing to Wyoming in 1987 totaled about $670 million, by far the most important source of income to the State.

During 1987, the U.S. Bureau of Land Management (BLM) had 60 mineral leases in effect for bentonite, phosphate rock, and trona. Six bentonite prospecting permits were active during the year, and 13 mineral patents were issued for bentonite claims. More than 234,000 unpatented mining claims were on record with the BLM in the State; during 1987, 3,564 new claims were recorded and 3,354 were closed. The majority of the new claims were staked on gold and uranium deposits. Wyoming received $153.5 million as receipts from the Mineral Leasing Act; most of the royalties were from oil, natural gas, and coal production. This $153.5 million figure represented nearly one-third of all Federal mineral royalties distributed during the year.

Wyoming received a grant of $54,984 in 1987 from the Mine Safety and Health Administration for safety and health activities and training at the State's 172 mines.

The Mining and Mineral Resources Research Institute at the University of Wyoming received a 1987 grant of $138,000 from the U.S. Bureau of Mines. The university had received $1.5 million since inception of the Mineral Institute program in 1978.

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REVIEW BY NONFUEL MINERAL COMMODITIES

INDUSTRIAL MINERALS

Cement.—Wyoming's one cement plant, at Laramie, owned by Centex Cement Corp. and operated by Mountain Cement Co., increased production by about 12%, although product value dropped about 3% from totals recorded in 1986. In midyear, Centex and Lone Star Industries Inc. formed a joint venture to manufacture and market cement in the Rocky Mountain region. Centex contributed the company's Laramie plant and one-half the working capital, while Lone Star contributed $27.5 million in cash, plus the remaining working capital. Large-scale renovations at the plant included installation of a two-stage preheater system to convert the kiln from a wet to dry process operation. The collapse of a storage tank soon after reopening prevented full-scale production in 1987; increased production was planned for 1988.

Cement production in 1987 was from clinker brought in from Colorado. Nearly all of the cement produced was general use and moderate heat Types I and II gray portland cement; a small quantity of masonry cement also was produced. Ready-mixed concrete companies provided the market for nearly 74% of the cement produced in the State, followed by highway contractors (21%), and building material dealers and other contractors (5%).

Clays.—Sodium bentonite and common clay and shale made up all of Wyoming's clay production; bentonite was significantly the largest amount produced. The State again ranked first in domestic bentonite production, accounting for about 76% of the Nation's output for the year. Wyoming's bentonite production, primarily sold for oil and gas well drilling muds and taconite pelletizing, reflected a modest revival in that industry, increasing about 22% in tonnage and more than 20% in value from that achieved in 1986.

Bentonite production was reported by 13 companies from 137 pits in 7 counties; 89% of the State's production came from Big Horn, Crook, and Weston Counties. Employment in the bentonite industry decreased by 41 people to 435; in 1981, during more prosperous times for the petroleum and steel industries, nearly 1,200 workers were employed.

Considerable corporate change in the State's bentonite industry took place during 1987. In midyear, American Colloid Co. purchased the Colony bentonite production facility from Applied Industrial Minerals Corp. for approximately $10 million. The cash transaction included the processing plant, inventories of mined bentonite, and mineral rights. In late October, American Colloid purchased the bentonite mining and processing assets and mineral reserves of Federal Ore and Chemical Inc., a wholly owned subsidiary of M-I Drilling Fluids Co. Included in the purchase were Federal's bentonite mining and processing operations in Colony and Upton, WY, and a processing facility in Burnett, MN. The Upton plant was put on standby until market conditions improve.

The Wyo-Ben Inc. plant at Lucerne was reopened in midyear; the company's Greybull operation operated on a three-shift, 6-day-per-week basis, and the Lovell plant worked 24 hours per day, 7 days per week during the latter part of the year. Approximately 40% of Wyo-Ben's production was used in drilling muds, another 40% for taconite pelletizing, and the balance in foundry and civil engineering applications.

Near yearend, American Bentonite Corp., a newly formed Billings, MT, firm, applied for permits to open two 3,000-acre bentonite mining areas in Natrona and Johnson Counties. American Bentonite had acquired the bentonite reserves of Petro-Chem Inc. in the Bolton-Bates Creek area about 20 miles southwest of Casper, Natrona County. The area American Bentonite planned to mine, however, is about 8 miles west of Casper. The Johnson County bentonite field is west of Kaycee. The company indicated that small-scale mining could commence as early as the summer of 1988.

Coping with long-term stagnation in the traditional bentonite consuming industries, Wyoming bentonite producers continued to experiment with and produce a variety of new products. Black Hills Bentonite produced a 1/2-inch-size screened product called gravel bentonite that was used to plug seismograph holes to prevent leakage into the water table. Black Hills also marketed a pulverized and screened granular product suitable for foundry applications.

Gem Stones.—Alluvial and lode jade continued to be collected in Wyoming, from scattered localities in an east-west trending band enclosing the Granite Mountains in southern Fremont and southwestern Natrona Counties. Some rubies also were recovered northwest of Jeffrey City. The Lac Minerals Ltd.-Mobil Oil Corp. joint venture

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continued exploration for diamonds in the State Line District of southern Albany County. Diamond Co. NL, a subsidiary of the Australian company, Carr Boyd Minerals Ltd., negotiated a mining lease and commenced exploration of five kimberlite intrusives in the State Line District on the Colorado-Wyoming border. The company's exploration effort for diamonds was expected to extend into Wyoming. In 1987, sampling by the GSW resulted in the identification of more than one dozen new heavy-mineral anomalies in the State, all derived from kimberlite or related ultrabasic or ultramafic rocks.

Gypsum.—The quantity of crude gypsum mined in Wyoming decreased by nearly 15% and the value was down by about 1% from 1986. The lowerod output was attributed to a substantial drop in gypsum used in cement manufacture and by a small decrease in gypsum mined for wallboard production.

Crude gypsum was produced by three companies in three counties. Mountain Cement mined gypsum at Red Mountain, Albany County; the mined product was used in cement manufacture at the Mountain Cement plant in Laramie. Georgia Pacific Corp.'s gypsum division at Lovell, Big Horn County, and the Celotex Div. of Jim Walter Corp., at Cody, Park County, mined and calcined gypsum for wallboard production.

Helium (Grade-A).—The first full year of Grade-A helium production in Wyoming increased output more than tenfold from that achieved in the startup year of 1986. The State was one of four to process Grade-A helium, and ranked second in production. Helium was Wyoming's third most important nonfuel mineral commodity in terms of value for 1987, ranking behind sodium carbonate and bentonite clay. Exxon Co. U.S.A. extracted the helium as a part of its Shute Creek natural gas operations in the Riley Ridge Gasfield of southwestern Wyoming. The cryogenic extraction process was used, followed by purification by pressure-swing adsorbtion. Almost all the helium was sold to private industry as liquid. Because the helium is on Federal lands, a royalty was paid to the Federal Government.

Lime.—The quantity of lime produced in the State increased by 16%, but the value decreased by about 8% from the production attained in 1986. Quicklime for sugar manufacture was produced by two companies in three counties—The Great Western Sugar Co. at Lovell, Big Horn County, and the Holly Sugar Corp. at Torrington, Goshen County, and at Worland, Washakie County. All the limestone used for this process was imported from other States. Lime also was used by several coal-fired electric generating plants for burn and emissions control. The limestone used in these plants came from Wyoming.

Perlite (Expanded).—Expanded perlite production was reported by Harborlite Corp. from a processing plant near Green River, Sweetwater County. Harborlite supplied perlite to the trona industry for use in filters at soda ash plants. The raw material for this production was imported from Arizona.

Phosphate Rock.—No mining of phosphate rock was reported from Wyoming in 1987, although phosphate rock was processed at Rock Springs. Chevron Chemical Co.'s $100 million phosphate fertilizer plant at Rock Springs successfully completed the first full year of production in 1987; the plant was operated at rates exceeding design capacity of 350,000 short tons of dry product to satisfy strong fertilizer sales demands. Phosphate rock plant feed was mined at Vernal, UT, and transported 95 miles by a slurry pipeline; Wyoming sulfur from Chevron's Carter Creek natural gas operation was used in the manufacturing process.

FMC Corp.'s Chemical Products Group increased capacity at its technical phosphate plant at Green River, Sweetwater County. The plant, the world's largest, had production capacity increased more than 50% to over 450 million pounds of sodium tripolyphosphate per year. The tripolyphosphate product is a primary constituent in detergents. Raw materials were elemental phosphorus from FMC's plant at Pocatello, ID, and soda ash from the Green River trona processing operation.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains estimates for 1985 and 1987 and actual data for 1986. Data for odd-numbered years are based on annual company estimates.

The estimated 1987 output of construction sand and gravel in Wyoming declined about 23% in quantity and 18% in value from that reported in 1986, when the last complete canvass was taken. According to the State Inspector of Mines, construction sand and gravel production was reported

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from 35 companies in 17 counties. The industry employed about 290 people in 1987.

Sodium Carbonate.—Wyoming accounted for approximately 90% of domestic soda ash production in 1987; the State's output increased by about 7% in volume and nearly 10% in value from 1986. The rise in production was attributed to increased exports and to an improved domestic demand for container glass and for specialized glass products, particularly flat glass and fiber-optic glass. Domestic consumption of soda ash in soaps and detergents decreased 8% in 1987, while the production of soda ash-based sodium silicates and sodium bicarbonate rose during the year. Production was reported from five trona mines and associated soda ash processing plants in the Green River Trona District, Sweetwater County. According to the Wyoming State Inspector of Mines, the 1987 underground trona mine output for the five producing companies was FMC Wyoming Corp., 3.87 million short tons; General Chemical Co., 3.31 million tons; Stauffer, 2.74 million tons; Tg Soda Ash Operations, 1.97 million tons; and Tenneco Minerals Co., 1.62 million tons. These production levels represented nearly 86% of nameplate capacity. Wyoming soda ash prices, which had risen from $69 per ton in 1983, to $83 per ton in 1986, advanced again in mid-1987 to $87 per ton.

FMC installed statistical process-control techniques at its Green River plant, and developed innovative mining patterns that doubled the tonnage of trona mined per unit shift. A safety inspection program initiated and run by mining crews and plant operators set a new safety record of no lost-time accidents in 1987.

In June, Stauffer, including the Green River soda ash operation, was sold for $1.6 billion by its parent company Chesebrough-Pond Inc. to Imperial Chemical Industries PLC (ICI) of the United Kingdom. In September, ICI, interested only in retaining Stauffer's agrichemical business, resold the basic chemicals branch, including the Green River operation, to Rhône-Poulenc S.A. Rhône-Poulenc, a French state-owned firm dealing in chemicals, pharmaceuticals, and textiles, paid ICI $522 million for the Stauffer basic chemicals unit. Rhône-Poulenc produces relatively high- cost synthetic soda ash at its European facility; exports from the purchased Green River operation might displace part of that production.

Recovery from Tg Soda Ash's third thickener, installed in the third quarter of 1986, was 10% to 15% better than expected; the unit recovered 75% of the soda ash formerly lost with the discarded underflow from the second thickener. In midyear, the company filed a plan with the DEQ to increase capacity at its soda ash plant from 1.0 million to 1.3 million tons of product.

Recalls of laid-off employees during 1987 indicated that economic conditions had improved in Wyoming's soda ash industry. General Chemical recalled about 40 of the 90 workers laid off in 1986, and FMC called back about 15 people at its operations. United Steelworkers of America Union employees at General Chemical signed a 3-year wage-freezing contract in August that could set the pattern for wages in the Green River District. Total 1987 employment in the district's Trona Patch, including baking soda, sodium tripolyphosphate, and sodium sesquicarbonate manufacture, was about 3,300; annual payroll, exclusive of fringe benefits, totaled more than $136 million.

Bonneville Transloaders Inc. (BTI) completed its third year of trucking soda ash 220 miles from the Green River District to a Burlington Northern railhead at Bonneville, north of Riverton. BTI's 30-truck fleet transported about 600,000 tons of soda ash in 1987. The truck transport to an alternative rail line serving eastern markets saved soda ash customers about $5 per ton in transportation costs. BTI transported about 7% of the State's soda ash production and accumulated about 620,000 miles per month on its truck fleet. The company had about 100 permanent employees and expended about $3.8 million in payroll and benefits in 1987.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains actual data for 1985 and 1987 and estimates for 1986. Data for even-numbered years are based on annual company estimates. Wyoming's crushed stone production increased by 56% in quantity and more than doubled in value over that recorded for 1985. The apparent large increase was explained in part by the publication in 1987 of data on crushed granite that were withheld in 1985. According to the annual report of the State Inspector of Mines, 18 companies produced crushed stone in 11 counties in 1987; the crushed stone industry employed about 160 people during the year.

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Table 3.—Wyoming: Crushed stone[1] sold or used by producers in 1987, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Coarse aggregate (+1-1/2 inch): Riprap and jetty stone	80	304
Coarse aggregate, graded:		
Concrete aggregate, coarse	337	1,038
Bituminous aggregate, coarse	307	1,066
Bituminous surface-treatment aggregate	62	304
Railroad ballast	1,423	6,349
Fine aggregate (-3/8 inch):		
Stone sand, Bituminous mix or seal	171	607
Screening, undesignated	195	2,471
Coarse and fine aggregates:		
Graded road base or subbase	168	545
Other construction[2]	134	1,167
Special: Other miscellaneous[3]	199	803
Other unspecified[4]	95	395
Total	3,171	15,049

[1]Includes limestone, dolomite, cinder (scoria), granite, marble, and other miscellaneous stone.
[2]Includes macadam, filter stone, fine aggregate, unpaved road surfacing, terrazzo and exposed aggregate, crusher run or fill or waste.
[3]Includes cement manufacture and other fillers or extenders.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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Sulfur (Recovered).—Wyoming ranked second among the 26 States producing recovered elemental sulfur; production in 1987 increased 50% in quantity and 39% in value from 1986. The State's sulfur was produced by energy companies as a byproduct from the processing of natural gas from the Overthrust Belt of southwestern Wyoming. The significant increase in sulfur output resulted from the first full year of production from Exxon's new Shute Creek natural gas processing plant in Lincoln County, west of Rock Springs, where the full-year production rate exceeded the plant's original design capacity. Eight companies reported sulfur recovery from operations in eight counties. More than 96% of Wyoming's 1987 production was credited to Exxon's Shute Creek operation, to Amoco Production Co.'s Whitney Canyon plant, and to Chevron's Carter Creek facility, the latter two in Uinta County.

Aurun Mines Ltd. and Equinox Resources Ltd. signed a joint-venture agreement to exploit the Sunlight Basin sulfur deposit in Park County. The partners leased 8 patented claims and planned to stake an additional 51 lode claims in the Shoshone National Forest. The deposit, which contains an estimated 1.2 million short tons of elemental sulfur occurring in altered igneous rocks, was reported to be the largest deposit of volcanogenic sulfur in North America. The permitting process was begun in 1987 for an $85,000 exploration and development program comprising mapping, sampling, and trenching.

[1]State Mineral Officer, Bureau of Mines, Spokane, WA.
[2]State geologist and executive director, Geological Survey of Wyoming, Laramie, WY.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Mountain Cement Co	Box 40 Laramie, WY 82070	Plant	Albany.
Clays:			
American Colloid Co	5100 Suffield Court Skokie, IL 60076	Pits and plants	Big Horn, Crook, Weston.
Federal Ore & Chemicals Inc	Box 9 Mills, WY 82644	do	Johnson, Natrona, Washakie.
M-I Drilling Fluids Co., Greybull Div.	Box 42842 Houston, TX 77242	Pits and plant	Big Horn.
NL Industries Inc., Baroid Div	Box 1675 Houston, TX 77251	Pits and plants	Big Horn and Crook.
Wyo-Ben Inc	Box 1979 Billings, MT 59103	do	Big Horn.
Gypsum:			
Celotex Corp	Box 590 Cody, WY 82414	Surface mine and plant.	Park.
Georgia-Pacific Corp	133 Peachtree St., NE. Atlanta, GA 30303	do	Big Horn.
Mountain Cement Co	Box 339 Laramie, WY 82070	Surface mine	Albany.
Helium (Grade-A):			
Exxon Co. U.S.A	Box 98 Frontier, WY 83121	Plant	Lincoln.
Lime:			
The Great Western Sugar Co	Box 5308 Denver, CO 80217	do	Big Horn.
Holly Sugar Corp	Holly Sugar Bldg. Colorado Springs, CO 80902	Plants	Goshen and Washakie.
Sodium carbonate:			
FMC Wyoming Corp	Box 872 Green River, WY 82935	Underground mine and plant.	Sweetwater.
General Chemical Co	Box 551 Green River, WY 82935	do	Do.
Stauffer Chemical Co. of Wyoming	Box 513 Green River, WY 82935	do	Do.
Tenneco Minerals Co	Box 1167 Green River, WY 82935	do	Do.
Tg Soda Ash Operations	Box 100 Granger, WY 82934	do	Do.
Stone (crushed):			
Frost Construction Co	Box 457 Lovell, WY 82431	Portable crushers.	Big Horn.
Gilbert Central Corp	Box 6206 Sheridan, WY 82801	Quarries and portable crushers.	Fremont, Platte, Sheridan.
Guernsey Stone Co	Box 339 Guernsey, WY 82214	do	Platte.

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Table 4.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone (crushed) —Continued			
Lamb Construction	Box N Torrington, WY 82240	Portable crushers.	Various.
Morrison-Knudsen Co. Inc	Box 1028 Cheyenne, WY 82003	Quarry	Laramie.
Rissler-McMurry Co	Box 2499 Casper, WY 82602	Portable crusher	Natrona.
Sulfur (recoverod):			
Amoco Production Co	Box 2520 Casper, WY 82602	Plant	Uinta.
Chevron USA Inc	Box AA Evanston, WY 82930	____do	Do.
Exxon Co. U.S.A	Box 98 Frontier, WY 83121	____do	Lincoln.

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